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Art. XII.—*Notice of Dr. Hooker's Flora Antarctica*;* by Prof. Asa Gray.

The Botany of Capt. Ross's Antarctic voyage of Exploration was announced to be published in two departments, viz., the Australian and New Zealand portion, which is still delayed, and the *Antarctic Flora*, which is now before us. The concluding fasciculus of this elaborate and highly beautiful work,—second in importance and in perfection of illustration, to no other Flora which has appeared in our time,—was issued a little more than a year ago; since which the indefatigable author has been gathering new *laurels* (literally new Rhododendrons by the dozen) upon the Himalayas, and is probably at this time exploring, with undiminished ardor, the luxuriant and entirely novel vegetation of Borneo. The patronage of the British government to the publication was bestowed in the form of a handsome grant from the Treasury, which has enabled the publishers to bring out the numerous plates in the highest style of the art, and to afford even the colored copies at a very moderate price indeed.

The materials elaborated in the *Flora Antarctica* consist not only of the full collections made during this voyage, by Dr. Hooker himself, and by the officers of the expedition, from the

* *The Botany of the Antarctic voyage of H. M. Discovery ships Erebus and Terror* in the years 1839–1843, under the command of Capt. Sir James Clark Ross, &c. By Joseph Dalton Hooker, M.D., R.N., F.R.S., &c., Botanist to the Expedition. Published under the authority of the Lords Commissioners of the Admiralty. London. Reeves, Brothers, 1845–7. Two vols. 4to, with 198 plates.

Commander downward,* but of nearly all previous Antarctic collections; among which were "the still unpublished herbaria formed by Sir Joseph Banks, Forster, and Solander in Cook's voyage, and Menzies in that of Vancouver." We may add that the collections made in the recent French Antarctic voyages, even the yet unpublished portions, were liberally shared with Dr. Hooker, for the purpose of giving greater completeness to the present work.

The first part of the Flora Antarctica is devoted to the botany of the few small islands which lie to the south of New Zealand, of which Lord Auckland's group and Campbell's island are the most important. No account of the botany of these islands had as yet been published. Their flora, as might be expected, proves to be closely related to that of New Zealand, "and does not partake of any of those features which characterize Australian vegetation."

The second part of the work treats of the botany of the other antarctic regions, exclusive of the Islands above mentioned; principally of Tierra del Fuego, the Falkland Islands, and Kerguelen's Land; the latter, from the characteristics of its vegetation, being associated with Fuegia, from which it is separated by 140 degrees of longitude, rather than with Lord Auckland's group, which is about 50 degrees nearer in geographical position. The introduction to this portion, like the whole work, abounds with interesting and very acute observations upon the laws which govern the geographical distribution of plants, especially as connected with physical geography and geology. We gather some extracts of this kind, as possessing more general interest to the readers of the Journal, than those disquisitions which relate to strictly botanical questions.

"A certain affinity in botanical productions has often been traced in widely severed countries, and Professor Forbes† has lately brought geological causes to bear immediately upon this

* Dr. Hooker remarks that there were few officers of either ship who did not contribute something to the collection of plants; and that the Commander, "whose private cabin was unreservedly placed at his disposal during the whole time the expedition was afloat, took a pleasure in promoting the interests of the collections at all times, and himself gathered many of the plants here described."

† "Professor E. Forbes has connected the similarity, long known to exist between the floras of the west of Ireland and Portugal, with certain geological characteristics belonging to both these now remote, but perhaps once united countries. * * Uniformity of surface is generally accompanied by a similarity of vegetation throughout an extended region. When such a surface becomes divided, we are apt to conclude that the isolation of the lesser portion preceded the migration of plants from the larger; in short, that the identity of the Norfolk and Suffolk flora with that of Holland, must be due to the former having been peopled with plants by the latter subsequently to the German Ocean having assumed its present position; and not that the two together formed an equally well clothed and extended plain, reaching, as Humboldt believes, from North Brabant to the steppes of Asia; its western portion having afterwards been insulated by the influx of the North Sea."

subject. In reference to this curious topic I would adduce, as corroborative perhaps of his speculations, the general geographical arrangement of these islands, whose botany I am about to describe as that of one country. They stretch from Fuegia on the west to Kerguelen's Land on the east, between the parallels of 45 and 46° of south latitude. Throughout this portion of the world the land exhibits a manifest tendency eastward, from the extreme south of the American continent; for there are no fewer than five detached groups of islands between Fuegia and Kerguelen's Land, but none between the latter island and the longitude of Lord Auckland's group, nor between this last again and the western shores of Fuegia and Patagonia. * *

"Tierra del Fuego and the neighboring southern extremity of the American continent appear to be the region of whose botanical peculiarities all the other Antarctic islands, except those in the vicinity of New Zealand, more or less evidently partake. It presents a Flora characterizing isolated groups of islands, extending for 5000 miles to the eastward of its own position; some of these detached spots are much closer to the African and Australian continents, whose vegetation they do not assume, than to the American; and they are all situated in latitudes and under circumstances eminently unfavorable to the migration of species, save that their position relatively to Fuegia is in the same direction as that of the violent and prevailing westerly winds."*

While Fuegia is to a considerable extent forest-clad, especially the western portions, the characteristic trees being the Deciduous Antarctic Beech with the Evergreen Beech, the Falkland Islands, though mainly lying more northward, produce no tree whatever.

"The botanical and other characters of the Falklands are allied to the Atlantic coast of Patagonia, opposite to the strait

* "The prevalence of certain winds in favoring the migration of plants must not be overlooked, though too much stress has been laid by some writers on their influence. An element that will carry particles of dust for hundreds of miles through the upper regions of the air, must be a powerful agent in disseminating the sporules of the lower orders of plants; so much so indeed, that I should unhesitatingly deny the necessity of a double creation, to account for the same species of moss or lichen inhabiting any two spots on the globe, however widely apart. That currents of air are not efficacious in wafting the seeds of the higher orders is proved by the absence in the British Isles of many common European plants; though, when once introduced by other means, they increase rapidly. We further see that the tide of vegetation (like the population) has, in the intertropical Pacific islands set in a direction contrary to the prevailing winds, namely from the Asiatic and not from the American shores; and again, that the botany of the North Atlantic islands, the Azores, Madeira, and the Canaries, though these groups are situated in the westerly winds, contain a large proportion of European species. The violence of the perennial westerly gales to the southward of 45°, is proverbial among sea-faring men: such winds carried H. M. S. Chanticleer from Cape Horn to the Cape of Good Hope, a distance of 4000 miles, in twenty-seven days, and have enabled an oceanic fowl, the Cape Pigeon, to maintain its position close to a ship during the whole of that distance; but still I am not inclined to attribute the prevalence of the Fuegian flora over so vast an area to their influence, when exerted against many other opposing agents."

of Magalhaens, from whence they are only three hundred miles distant. The most evident causes of the absence of trees in the Falkland Islands are the dislocation or removal of that group from the main land; their comparatively plane surface, every where exposed to the violence of westerly gales; and more especially to the rapid evaporation and sudden changes in temperature, and in other meteorological phenomena. The southerly and westerly winds are violent, cold, and often accompanied by heavy snow-storms; the easterly and northerly arrive saturated with warmer sea vapors, which, quickly condensing over the already chilled surface of the soil, form fogs and mists that intercept the sun's rays; while the northwesterly winds are singularly dry and parching, from the influence of the Patagonian plains over which they blow. Such sudden alternations from heat to cold, and from damp to dry, are particularly inimical to luxuriant vegetation, and no foliage but perhaps the coriaceous growth of Australia could endure them. * *

"In January, 1843, I landed upon a small islet, close to the main portion of Palmer's Land, in latitude 64° 12′ S. and longitude 57° W. It appeared to be the 'Ultima Thule' of southern vegetation; the soil hard frozen, except on the very surface, where it was thawed by a sun-heat which raised the temperature to 46°, while the sea was encumbered with pack-ice and bergs. No flowering plants were to be seen, and only eighteen belonging to the orders *Lichens*, *Musci* and *Algæ*. Beyond this latitude, I believe there is no terrestrial vegetation."

We add a portion of the remarks upon Kerguelen's Land, which, though lying within the 50th degree of latitude, appears well to deserve its synonyme of the "Isle of Desolation."

"The island presents a black and rugged mass of sterile mountains, rising by parallel steps one above another in alternate slopes and precipices, terminating in frightful, naked and frowning cliffs which dip perpendicularly into the sea. The snows lying upon these slopes between the black cliffs gave a most singularly striped appearance to the whole country, each band indicating a flow of volcanic matter; for the island is covered with craters whose vents have given issue to stream upon stream of molten rock. These are all worn along the coasts into abrupt escarpements, rendering a landing impracticable except at the heads of the sinuous bays. One bluff headland to the north of the island is a precipice seven hundred feet high, and exposes such numerous sections of horizontal deposits of red, black, and gray volcanic matter that it is difficult to count them, though overlaying one another with perfect regularity and uniformity. Sterile as Kerguelen's Land now is, it was not always so. Vast beds of coal are covered by hundreds of consecutive layers of igneous and other rocks, piled to a height of 1000 feet and upwards upon what was once a luxuriant forest. Throughout many of the lava-streams are

found prostrate trunks of fossil trees of no mean girth, and the incinerated remains of recent ones, which had been swallowed up simultaneously with the fossil; and these occur in strata of various ages, so that it seems impossible to reckon the period of time that must have elapsed between the origin, growth, and destruction of the successive forests now buried in one hill. A section of such a hill would display coal beds and shale resting upon a blue basalt, at the level of the sea, covered again with whinstone, whereon are deposited successive layers of volcanic sand, baked clay-stones, porphyries, and long lines of basaltic cliffs, formed of perpendicular prisms, regularly sloped like those of Staffa or the Giants Causeway, and along which the traveller may walk even for a mile without ascending or descending fifty feet. To calculate the time required for the original formation following silicification of one such forest, and to multiply that by the number of different superincumbent strata, containing remains similar to those displayed at the north end of Kerguelen's Land, would give a startling number of years, during which periods the island must have deserved a better name than that of 'Desolation.' And if to this be added the time necessary for the deposit of the arenaceous beds containing the impressions of *Fuci*, of the clays afterwards hardened by fire, and of the prismatic cliffs, which, with the arenaceous, indicate that the land was alternately submerged and exposed as often as those successive formations occur, such a sum would bespeak an antiquity for the flora of this isolated speck on the surface of our globe far beyond our powers of calculation."

This island, the remotest of any from a continent, in the most inhospitable climate, now yields only eighteen flowering plants; but one of these is a very important one, namely the *Kerguelen's Land Cabbage*, which the readers of Capt. Cook's voyage will not fail to remember. It appears that Mr. Anderson, the surgeon and naturalist of Cook's first voyage, and who successfully used this plant to check the scurvy which was making such ravages among the crew, on his return, drew up an account of the remarkable plants he collected, which is still preserved in the Banksian Library; and that to this he applied the name of *Pringlea*, in honor of Sir John Pringle who wrote a work on the scurvy. In now completing and giving to the world the botanical account of this plant, Dr. Hooker has most properly adopted this name, adding, at Mr. Brown's suggestion, the specific appellation of *antiscorbutica*. He thus discourses upon the plant.—

"The contemplation of a vegetable very unlike any other in botanical affinity and in general appearance, so eminently fitted for the food of man, and yet inhabiting one of the most desolated and inhospitable spots on the surface of the globe, must equally fill the mind of the scientific enquirer and common observer with

wonder. The very fact of Kerguelen's Land being possessed of such a singularly luxuriant botanical feature, confers on that small island an importance far beyond what its volcanic origin or its dimensions would seem to claim; whilst the certainty that so conspicuous a plant can never have been overlooked in any larger continent, but that it was created in all probability near where it now grows, leads the mind back to the epoch far anterior to the present, when the vegetation of the Island of Desolation may have presented a fertility of which this is perhaps the only remaining trace. Many tons of coal and vast stores of now silicified wood, (which I have mentioned in the introduction to this Part,) are locked up in or buried under those successive geological formations which have many times destroyed the forests of this island, and as often themselves supported a luxuriant vegetation. The fires that desolated Kerguelen's Land are long ago extinct, nor does the island show any signs of the recent exertion of those powers, that have at one time raised parts of it from the beds of the ocean with those submarine Algæ which once carpeted its shores but which now are some hundred feet above the present level of the sea. The *Pringlea*, in short, seems to have led an uninterrupted and tranquil life for many ages; but however loth we may be to concede to any one vegetable production an antiquity greater than another, or to this island a position to other lands wholly different from what it now presents, the most casual inspection of the ground where the plant now grows, will force one of the two following conclusions upon the mind; either that it was created after the extinction of the now buried and forever lost vegetation, over whose remains it abounds, or that it spread over the island from another and a neighboring region where it was undisturbed during the devastation of this, but of whose existence no indication remains.

"The *Pringlea* is exceedingly abundant over all parts of the island, ascending the hills up to 1400 feet, but only attaining its usual large size close to the sea, where it is invariably the first plant to greet the voyager like the *Cochlearia* or scurvy grass upon the northern coasts. Its long rhizomata, often three or four feet long, lie along the ground; they are sometimes two inches in diameter, full of spongy and fibrous substances intermixed, of a half woody texture, and with the flavor of horse-radish, and bear at the extremity large heads of leaves, sometimes eighteen inches across, so like those of the common cabbage that, if growing in a garden with their namesakes in England, they would not excite any particular attention; the outer leaves are coarse, loosely placed and spreading, the inner form a dense white heart, that tastes like mustard and cress, but is much coarser. The whole abounds with essential oil of a pale yellow color, highly pungent, and confined in vessels that run parallel with the veins

of the leaf, and which are very conspicuous on making a transverse section of the head. During the whole stay of the Erebus and Terror in Christmas Harbor, daily use was made of this vegetable, either cooked by itself or broiled with the ships' beef, pork, or pea-soup. The essential oil gives a peculiar flavor which the majority of the officers and the crew did not dislike, and which rendered the herb even more wholesome than the common cabbage; for it never caused heart-burn, or any of the unpleasant symptoms which that plant sometimes produces. Invaluable as it is in its native place, it is very doubtful whether it will ever prove equally so in other situations. It is of such slow growth that it probably could not be cultivated to advantage. * * * * Growing spontaneously and in so great abundance where it does, it is likely to prove, for ages to come, an inestimable blessing to ships touching at this far distant isle, whilst its luxuriance amid surrounding desolation, its singular form and appearance striking even the casual observer, and the feelings of loneliness and utter isolation from the rest of the world that must more or less oppress every voyager at first landing on its dreary and inhospitable locality, are circumstances likely to render the Kerguelen's Land cabbage—cabbage though it be—a cherished object in the recollection of the mariner; one never to be effaced by the brighter or luscious products of a tropical vegetation."

Dr. Hooker's account of the *Balsam-bog* (Bolax glebaria) of the Falkland, as originally printed in the *Icones Plantarum*, was extracted for this Journal on a former occasion. (Vol. iii, 2d ser., 121.)

Nothing can be more interesting to the vegetable physiologist, than his complete and most able account of the anatomical structure and parasitism of *Myzodendron*, a Fuegian genus of woody parasites of the Mistleto family, illustrated by a series of incomparable figures, which have won for the youthful author an enviable reputation for his talents in that department of investigation. These plates (102 to 107, 107 *bis*, and 107 *ter*) are the great glory of the work. Want of room alone prevents our noticing Dr. Hooker's excursus on the potato, and his interesting account of the Antarctic beeches, the two principal species of which have been imported into England by this expedition, where they promise to succeed well. But we must by no means omit the famous Tussock grass (Dactylis cæspitosa) of the Falkland Islands, which, successfully raised from seeds, bids fair to thrive in Great Britain. It would be well to try it on our own shores, but we can scarcely expect it to live in our extreme climate. The summers of the foggy coast of Maine would doubtless agree with it; but it would hardly withstand the winter even of New Jersey, where probably the summer is too dry.

"It was not until the recent colonization of the Falklands by the British, that attention was particularly directed to the

Tussock, in consequence of accounts forwarded to the colonial office by Governor Moody, and to the Admiralty by the Antarctic Expedition. The peculiar mode of growth of *Dactylis cæspitosa* enables it to thrive in pure sand, and near the sea, where it has the benefit of an atmosphere loaded with moisture, of soil enriched by decaying sea-weeds, of manure, which is composed in the Falkland Islands of an abundant supply of animal matter in the form of guano, and of the excrements of various birds, who deposit their eggs, rear their young, and find a habitation amid the groves of tussock. Its general locality is on the edges of those peat bogs which approach the shore, where it contributes considerably to the formation of peat. Though not universal along the coast of these islands, the quantity is still prodigious, for it is always a gregarious grass, extending in patches sometimes for nearly a mile, but seldom seen except within the influence of the sea air. This predilection for the ocean does not arise from an incapacity to grow and thrive except close to the salt water, but because other plants, not suited to the seashore, already cover the ground in more inland localities, and prevail over it: I have seen the tussock on inaccessible cliffs in the interior, having been brought there by the birds and afterwards manured by them; and, when cultivated, it thrives both in the Falklands and in England, far from the sea. I know of no grass likely to yield nearly so great an amount of nourishment as the Tussock when thoroughly established; in proof of which, I quote my friend Governor Moody's printed report, for the truth of which I can vouch, both from my own experience and from his having kindly given me ample means for judging of the correctness of his interesting and useful observations, when drawing up the report from which the following extract was made. 'During several long rides into the country I have always found the Tussock flourishing most vigorously in spots exposed to the sea, and on soil unfit for any other plant, viz.: the rankest peat-bog, black or red. It is wonderful to observe the beaten foot-paths of the wild cattle and horses, marked like a foot track across the fields of England, extending for miles over barren moor-land, but always terminating in some point or peninsula covered with this favorite fodder; amid which one is almost certain to meet with solitary old bulls, or perhaps a herd of cattle; very likely, a troop of wild horses, just trotting off as they scent the coming stranger from afar. To cultivate the Tussock grass, I should recommend that its seeds be sown in patches, just below the surface of the earth and at distances of about two feet apart; it must afterwards be weeded out, for it grows very luxuriantly, frequently attaining a height of six or seven feet. It should not be grazed, but cut or reaped in bundles. If cut, it quickly shoots again; but is injured much by grazing; for all animals, especially pigs,

tear it up to get at the sweet nutty-flavored roots. I have not tried how it would be relished if made into hay, but cattle will eat the thatch off the roof of a house in winter; their preference to Tussock grass being so great that they scent it a considerable distance and use every effort to get at it. Some bundles which had been stacked in the yard at the back of the government house, were quickly detected, and the cattle in the village made every night repeated attempts to reach them, which occasioned great trouble to the sentry on duty.' Since the above was written, the Tussock has been used abundantly when made into hay, being preferred by the cattle even to the green state of any of the other excellent grasses in the Falklands. Governor Moody informs me that in his garden it grows rapidly and improves by cutting. There is, however, one drawback to the value of the Tussock; it is a perennial grass, of slow growth, and some disappointment has been experienced in England from this cause. Each Tussock consists of many hundreds of culms, springing up together from a mass of roots, which have required a long series of years to attain their great and productive size. Our cultivated specimens in the royal gardens of Kew, now nearly three years old, are in a fair way of becoming good Tussocks, for the quantity of stems from each root, the produce of one seed, is incalculably more than any other grass throws up; but this ball, now scarcely six inches across and not two in height, must have grown to six or eight feet high, with a diameter of three or four feet; instead of forty culms, there must be four hundred; and the leaves, now three feet long, must attain seven, ere the Tussock of England can compete with its parent in the Falklands. Though, however, the stoles (if I may so call the matted roots of this grass) in the most vigorous and native specimens attain the height of seven feet, it is certain they are very productive before they have reached two or three. By this time the leaves have gained their great size, the bases of the culms are nearly as broad as the thumb, and when pulled out young, they yield an inch or two of a soft, white, and sweet substance, of the flavor of a nut, and so nutritious, that two American sealers, who deserted a vessel in an unfrequented part of the Falklands, subsisted on little else for fourteen months. There are few plants which from perfect obscurity have become objects of such interest as this grass. The Tussock in its native state seems of almost no service in the animal economy. A little insect, and the only one that I observed, depends on it for sustenance; a bird, no bigger than the sparrow, robs it of its seeds; a few seafowl build among the shelter of its leaves; penguins and petrel seek hiding places among its roots, because they are soft and easily penetrated, and the sea-lions cower beneath its luxuriant foliage; still, except the insect, I know no animal or plant whose

extinction could follow the absence of this, the largest vegetable production in the Falklands, which does not even support a parasitical fungus. These same sea-birds breed or burrow where no Tussock grows; rocks elsewhere suit the sea-lion's habits equally well; and the sparrow, which subsists on other food eleven months of the year, could surely make a shift without this for the twelfth. Certain it is that the Tussock might yet be unknown and unprized amongst plants, if cattle had not been introduced to its locality by man: who thus became, first the injurer, and then the protector and propagator of the existence of this noble grass; for the herbivorous quadrupeds which he carried to the Falklands and left there, were surely extirpating the Tussock, when man returned, and by protecting, perpetuating, and transporting it to other countries, he has wisely dispersed it. It appears singular that so striking a grass should abound where there is no native herbivorous animal to profit by its luxuriance; but it is no less certain that had not civilization interfered, the Tussock might have waved its green leaves undisturbed over the waters of the stormy Antarctic Ocean, forever perhaps, or until some fish, fowl, or seal, should be so far tempted by the luxuriance of its foliage as to trangress the laws of nature, and to adapt its organs to the digestion and enjoyment of this long neglected gift of a bounteous Providence."

But we must not pass by the interesting account of the two gigantic races of sea-weed in the southern ocean, *Lessonia* and *Macrosystis*. It is to the description of *Lessonia fucescens*, of the Falklands, &c., that the subjoined remarks are appended.

"This and the following are truly wonderful *Algæ*, whether seen in the water or on the beach; for they are arborescent, dichotomously branched trees, with the branches pendulous and again divided into sprays, from which hang linear leaves 1–3 feet long. The trunks are usually about 5–10 feet long, as thick as the human thigh, rather contracted at the very base, and again diminishing upwards. The individual plants are attached in groups or solitary, but gregarious, like the pine or oak, extending over a considerable surface, so as to form a miniature forest, which is entirely submerged during high-water or even half-tide, but whose topmost branches project above the surface at the ebb. To sail in a boat over these groves on a fine day, affords the naturalist a delightful recreation; for he may there witness, in the Antarctic regions, and below the surface of the ocean, as busy a scene as is presented by the coral reefs of the tropics. The leaves of the *Lessonia* are crowded with *Sertulariæ* and *Mollusca*, or encrusted with *Flustræ;* on the trunks parasitic *Algæ* abound, together with Chitons, Patellæ, and other shells; at the bases, and among the tangled roots, swarm thousands of Crustacea and Radiata, whilst fish of several species dart amongst the

leaves and branches. But it is on the sunken rocks of the outer coasts that this genus chiefly prevails, and from thence thousands of these trees are flung ashore by the waves, and with the *Macrosystis* and *D'Urvillea*, form along the beach continued masses of vegetable rejectamenta, miles in extent, some yards broad, and three feet in depth; the upper edge of this belt of putrefying matter is well in shore, whilst the outer or seaboard edge dips into the water, and receives the accumulating wreck from the sub-marine forests throughout its whole length. Amongst these masses the best *Algæ* of the Falklands are found, though if the weather be mild, the stench, which resembles putrid cabbage, is so strong as to be almost insufferable. The ignorant observer at once takes the trunks of *Lessonia* thus washed up for pieces of drift-wood, and on one occasion, no persuasion could prevent the captain of a brig from employing his boat and boat's crew, during two bitterly cold days, in collecting this incombustible weed for fuel."

"The ramification of all the species of *Lessonia* is dichotomous; each plant in a young state consists of a few rooting and clasping fibres, giving off a single stem (or petiole) and frond. This frond splits at the base, and as the growth proceeds, the fissure extends vertically upwards, till the original frond is bisected; each of the two parts is now a complete frond, altogether similar to the primary one, and provided with a petiole of its own: these again divide, and the process is repeated. Hence the rapid growth of this genus, and hence the origin of the flattened form of ramuli and elliptic core which is placed in the long axis of these ramuli and across the axis of the terete stem. It was not observed whether any relation existed between the number of branches on the whole frond and of concentric rings in the trunk. The latter are probably the indices of the number of times that a subdivision of the laminæ has accrued, supposing that all split at about the same epoch, rather than a register of the years the vegetable has existed; as the following account of the anatomy of this species will show.

"A branched portion of the plant, terminated by four laminæ, necessarily presents subdivisions of three periods of growth: 1st, the petioles of the four laminæ; 2d, the two ramuli from which the four are given off; 3d, the one branch which gives off the two latter: these were successively examined.

"1. The base of the laminæ or petiole is exceedingly compressed, and composed of a mass of cellular tissue of different textures, all, however, very gelatinous, and modifications of the three layers forming the leaf; there are 1st, the superficial tissue (or cortex) consisting of small cells, closely packed, and full of chromule, gradually opening out into, 2d, an intermediate tissue of much larger cells more loosely placed, with little or no contained chro-

mule, separated by much gelatine; and 3d, an elliptical core placed in the long axis of the petiole, composed of still smaller cells, separated by broader masses of gelatine, which latter is permeated by canals, full, as are the small cells, of chromule."

"2. Each ramulus, from which proceed the two petioles, whose structure we have just described, presents no very important difference from them; the core no longer stretches across it, however, but the whole petiole within the superficial portion is augmented by a newly developed though indistinct zone of cellular tissue, thus deposited between the superficial (or cortical) and intermediate tissue. At this period the cortex is somewhat broader, and the intermediate tissue has become through the absorption of the gelatine, much more conspicuous; the cells being longer and the spaces between them narrower; little or no change is perceptible in the core itself.

"3. The branch is very materially different from either of the above, for what was hitherto the petiole is now enclosed (all but its cortex) in a very broad zone of cellular tissue, whose cells are large and thin towards the old tissue, elongated and of a different shape, so as to show the line of separation between the two periods of growth.

"From this time forward the normal mode of growth followed by the stem, exhibits an additional layer or zone of cellular tissue for every subdivision of the frond, (shown at A 1, where six are interposed between the cortex and core.) It is not probable, however, that this numerical relation can be always evident, or that the number of subdivisions of the frond will indicate the rings of growth in a large stem. This uncertainty arises from the branches being frequently broken off; added to which, the growth of the sea-weed is very rapid, and there being no period of rest, irregular zones may be expected, or their absence from those branches of the plant whose leaves are injured.

"I have stated the growth of the *Lessonia* to be very rapid; this is proved by the zones of a five-ridged stem being progressively broader towards the circumference. The probability, too, of one being added for every time the laminæ divide, and the fact that the process of subdivision is continued in geometrical progression, all favor the opinion that these Algæ attain their enormous bulk in a very few months. The vast masses washed up on the outer eastern shores of the East Falkland Island, and the rapidity with which they decay, are additional proofs of a singularly rapid development.

"The analogy between the mode of growth exhibited by this genus and an exogenous tree, is, though incomplete, very obvious; both increase by layers deposited outside one another, within a cortical substance, and both contain an axis of tissue different from that forming the greater part of the trunk: here, however,

there are no traces of medullary rays. We conclude this subject with the observation, that the periodical increment of the trunk being dependent on, or coincident with, the formation of the laminæ, these appear to perform the office of the leaves in the higher order of plants; and that the *Lessonia* is also in this respect analogous to an Exogenous plant, deprived of its woody tissue, for it is a stem composed of layer upon layer of cellular tissue, deposited round an axis, which, like the pith, when once formed, is afterwards but slightly modified."

The ten described species of the gigantic *Macrosystis*, Dr. Hooker's own observations have enabled him to reduce to one; remarking that few botanists in Europe have ever seen even a tolerable suite of specimens from one single plant of this Alga, such as give a fair idea of the differences between the various leaves and bladders along some 300 feet of stem, with the submerged fructifying fronds from the root. The general interest of the following account must be our apology, if one is needed, for so lengthened a series of extracts.

"It is seldom that the history of *an Alga* is likely to afford interest or amusement to the general reader, unless it be a positively valuable plant in an economic point of view. Like the Sargasso-weed of the Tropics, however, the *Macrosystis* is so conspicuous, and from its wandering habits, often occurs so unexpectedly, that the attention of our earliest voyagers has been directed to it, and we are consequently led back by our enquiries into its first discovery, to the annals of those perils and privations which have ever marked the progress of discovery and enterprise in the stormy seas of the south. 'Nihil vilior Alga,' is a saying more trite than true, and one which a seaman can never use; for these weeds often prove his unerring guide towards land, as they surely are to the direction of the currents; or become of more importance still in the case of the present plant; for it is, where growing, not only the infallible sign of sunken rocks, but every rock that can prove dangerous to a ship is conspicuously buoyed by its slender stem and green fronds, and we may safely affirm that without its presence many channels would be impracticable, and numerous harbors in the south closed to our adventurous mariners.

"The first notice of the *Macrosystis*, with which we are acquainted, is of so early a date as the middle of the 16th century, and occurs in a copy of sailing directions for mariners, with the title 'A Ruttier from the river of Plate to the Streight of Majelana,' and forms part of 'A special note concerning the currents of the sea between the Cape of Buena Esperanza and the coast of Brazilia, given by a French pilot before Sir John Yorke, Knt., before Sebastian Cabote, which pilot had frequented the shores of Brazilia eighteen voyages.' (Hakluyt, ed. 2, vol. iv, p. 219).

In describing the above mentioned route, after passing Cape Sta. Martha, the trusty pilot's direction to the mariner is to 'goe S. W. by W. until he be in 40 degrees, where he shall find great store of weedes which come from the coast;' and again, in pursuing the voyage after entering the Straits, 'if you see beds of weede, take heed of them and keep off from them.' Now, both the position assigned to the great masses of floating weed and the value of those which are attached in denoting hidden dangers, are conclusive as applying to the *Macrosystis*. These directions bear no date; but the discovery of the Strait of Magalhaens was in 1520, and the death of Sebastian Cabote took place in 1556, so that we have sufficient proof that this attracted the attention of the earliest Antarctic voyagers in the longitudes of Cape Horn; though it may have been noticed previously on the southern extreme of Africa or the China seas. Nor can we wonder that the attention of our forefathers should have been so early called to it, when even now it is of the first importance that the look-out man should use his utmost vigilance to detect, and promptitude to report, this weed on approaching any of the straits and bays of the shores of Tierra del Fuego and similar latitudes. In the latest voyages that have been published, those of Capt. Foster, King, and Fitzroy, we find a constant watch for the 'Kelp' to have been kept, and caution used to avoid the 'moored' pieces, together with instructions how to distingushed them from those which are floating.

"So remarkable a plant was not likely to escape the notice of Cook, and especially of the illustrious companions of that navigator's first voyage, and we accordingly find in his narrative repeated allusion to it. It engaged the attention of Banks when entering the Straits of LeMaire in 1769, and frequently afterwards in the cooler latitudes of the Southern ocean. To him we owe the first account of its gigantic dimensions. Captain Cook says, on the authority of Banks and Solander, who called it *Fucus giganteus*, that the stems attain a length of 120 feet. That these dimensions are considerably under the mark, there is little doubt; though the report that specimens have been measured upwards of 1000 feet, is perhaps as much of an exaggeration. Still it must be remembered that, provided the water be smooth and of sufficient extent, there are no impediments to the almost indefinite elongation of the upper part of a plant which never branches, or whose growth is independent of all below it, even of the root. Specimens measuring between 100 and 200 feet are common in the open ocean, and these are always broken off at the lower end, either from the division of the frond by sea-animals, through whose agency the plant increases and the floating island it forms dilates, or from the impossibility of securing the whole mass from the motion of the vessel or the swell

of the sea, in latitudes where no boat can be lowered. Again, D'Urville, upon whose observations in natural history the utmost reliance may be placed, states it to grow in eight, ten, and even fifteen brasses of water, from which depth it ascends obliquely and floats along the surface nearly as far; this gives a length of 200 feet. In the Falkland Islands, Cape Horn, and Kerguelen's Land, where all the harbors are so belted with its masses that a boat can hardly be forced through it, it generally rises from eight to twelve fathoms water, and the fronds extend upwards of one hundred feet upon the surface. We seldom, however, had opportunities of measuring the largest specimens, though washed up entire on the shore; for on the outer coasts of the Falkland Islands, where the beach is lined for miles with entangled cables of *Macrosystis*, much thicker than the human body, and twined of innumerable strands of stems coiled together by the rolling action of the surf, no one succeeded in unravelling from the mass any one piece upwards of seventy or eighty feet long; as well might we attempt to ascertain the length of hemp fibre by unlaying a cable. In Kerguelen's Land, the length of some pieces, which grew in the middle of Christmas Harbor, was estimated at more than three hundred feet; but by far the largest seen during the Antarctic Expedition, were amongst the first of any extraordinary length which the ships encountered, and they were not particularly noticed, from the belief that the report of upwards of 1000 feet length was true; or, at any rate, that better opportunities of testing its truth would arise in the course of a three years' voyage, than the first week of our explorations could afford. These occurred in a strait between two of the Crozet Islands, where, very far from either shore, in what is believed to be forty fathoms water, somewhat isolated stems of *Macrosystis* rose at an angle of 45° from the bottom, and streamed along the surface for a distance certainly equal to several times the length of the "Erebus;"— data, which, if correct, (and we believe them so) give the total length of the stems as about 700 feet.

"That isolated patches of weed should rise through such a volume of water is not incompatible with the statements we have elsewhere made, that eight or ten fathoms is the utmost depth at which, judging by our experience, submerged sea-weed vegetates in the Southern temperate and Antarctic Ocean. These exceptional cases are probably due to the present plant having attained such a size in its birth-place near shore, as to weigh its strong moorings and deposit itself in deeper water, where an increase of the roots would unite the original base to other rocks, and thus gain a footing that defies the power of the elements.

"We have stated that the elongation of the *Macrosystis* may be indefinite; but this is only true partially and in the case of detached patches; for the stem of the attached plant does not gain

bulk or tenacity, after a certain period; whilst the growing dimensions of the floating portion are increasing the difference between the specific gravity of the vegetable and the element it inhabits, and consequently augmenting the strain upon the slender stem by which it is attached. At some period or other, the resistance is overcome and the floating part detached from the submerged; though at what epoch this may take place, or whether it be coincident with other phases in the life of the plant, is beyond our conjecture.

"The fact that fructification is produced only on the submerged young bladderless and small frond, within a few inches of the very root, is highly remarkable. What then is the function of the floating mass of the plant? to one of whose thousand leaves, each four to six feet long, the fructifying bears an inconceivably small proportion. Were this a phænogamic plant, we should recognize, in such foliaceous expansions, organs which fulfil a respiratory and digestive office and are subservient and necessary to the development of the more important parts of the vegetable; but in this case such a mutual dependency is not so easily traced. As in *Lessonia* the multiplication of the leaves is intimately connected with the development in diameter of the stem, so in *Macrosystis* the development of fructifying fronds may take place only at the root of the barren ones, on whose previous existence they may be dependent for their origin. These are, however, questions which propose themselves to us in the closet only, when the prospect of solving them is gone by; and when they but add to the thousand regrets over lost opportunities, the remembrance of which weighs so heavily on the mind of every naturalist, that the brightest prospects of discovery in the fair future can never obliterate them."

The general remarks of our author upon the distribution, economy and functions of the Antarctic Diatomaceæ are so just and so full of scientific interest, that we deem it our duty to afford them a wider circulation among our American readers, very few of whom, probably, will ever see them in the original work.

That the Diatomaceæ belong to the vegetable, and not to the animal kingdom, has of late years seemed altogether the most probable opinion; and this idea has recently been unequivocally confirmed by Mr. Thwaites, who has most successfully investigated this tribe in England, and who has had the good fortune to discover several species congregating, in the manner of the Zygnemata, a fact which leaves no doubt of their vegetable nature.

That *Volvox*, also, is a vegetable, would hardly be doubted, except for its active movements, which, being at some period common to the spores of every tribe of Algæ, cease to furnish a criterion. We learn that Prof. Braun of Carlsruhe, has recently studied the development of Volvox, and has clearly demonstrated

their vegetable nature. Following the high authority of Ehrenberg, Dr. Hooker had supposed the Diatomaceæ to pertain to the animal kingdom, and consequently had supposed all vegetation to cease at a much lower latitude than these productions attain. He collected them, however, on every available occasion during the voyage, and on his return transmitted them to Prof. Ehrenberg, whose determination of the genera and species is introduced into the Flora Antarctica, where they find a place as a distinct order of plants. The circumstances under which they occur, and the modes in which they were collected and preserved for examination are thus described.

"The waters and the ice of the South Polar Ocean were alike found to abound with microscopic vegetables belonging to this order. Though much too small to be discernible by the naked eye, they occurred in such countless myriads as to stain the berg and the pack-ice, wherever they were washed by the swell of the sea; and when enclosed in the congealing surface of the water, they imparted to the brash and pancake ice a pale ochreous color. In the open sea northward of the Frozen zone, this order, though no doubt almost universally present, generally eludes the search of the naturalist; except when its species are congregated amongst that mucous scum, which is sometimes seen floating on the waves, and of whose real nature we are ignorant; or when the colored contents of the marine animals who feed on these Algæ are examined. To the south, however, of the belt of ice which encircles the globe, between the parallels of 50° and 70° S., and in the waters comprised between that belt and the highest latitude ever attained by man, this vegetation is very conspicuous, from the contrast between its color and the white snow and ice in which it is imbedded. Insomuch that, in the 80th degree all the surface ice carried along by the currents, the sides of every berg, and the base of the great Victoria Barrier itself, within reach of the swells, were tinged brown, as if the polar waters were charged with oxyd of iron.

"As the majority of these plants consist of very simple vegetable cells, enclosed in indestructible silex (as other Algæ are in carbonate of lime), it is obvious that the death and decomposition of such multitudes must form sedimentary deposits, proportionate in their extent to the length and exposure of the coast against which they are washed, in thickness, to the power of such agents as the winds, currents, and sea, which sweeps them more energetically to certain positions, and in purity, to the depth of the water and the nature of the bottom. Hence we detected their remains along every ice-bound shore, in the depth of the adjacent ocean, between eighty and one hundred fathoms. Off Victoria Barrier (a perpendicular wall of ice, between one and two hundred feet above the level of the sea) the bottom of the ocean

was covered with a stratum of pure white or green mud, composed principally of the siliceous cells of Diatomaceæ. These, on being put into water, rendered it cloudy, like milk, and took many hours to subside. * * *

"Scattered on the surface of the ocean, the Antarctic Diatomaceæ were seen connected in filaments, or resolved into the simple frustutes of which they are composed. When entire, they showed no signs of motion or irritability. The grumous or granular contents of the cells were yellow under the microscope; but in most the same species assumed an orange-brown, or burnt sienna color, the intensity of which depended on the denseness with which they were packed together.

"The various means employed for selecting the species varied according to circumstances, as the following enumeration of the processes pursued will show. 1. Sea water was filtered through closely woven bibulous paper (filter paper), which latter was folded, dried, and carefully put away. If a certain measure of water be always thus treated, an approximate knowledge of the abundance and scarcity of the various species and genera occurring at different positions may be gained. 2. The scum of the ocean almost invariably contains many species entangled in its mass; it was preserved in small vials, well secured. 3. A tow-net of fine muslin, used when the vessels' rate does not exceed two or three knots, secures many kinds, which may be washed off the muslin and collected on filter paper. 4. The stomachs of *Salpæ* and other (especially of the naked) mollusca invariably contain Diatomaceæ, sometimes several species. These *Salpæ* were washed up in masses on the pack-ice, and in decay they left the snow covered with animal matter, impregnated as it was, with Diatomaceæ: the *reliquiæ* were preserved in spirits. 5. The dirt and soil of the *Penguin rookeries* and especially their guano abound in Diatomaceæ, perhaps originally swallowed by salpæ and cuttle fish, which themselves become the prey of the penguins. 6. Ice encloses Diatomaceæ: they are deposited on the already formed ice by the waves, or frozen into its substance during calm weather, where the upper stratum of water rapidly congeals. Ice so formed generally breaks up by the swell of the sea into thin angular masses, which become orbicular by attrition, whence the name pancake ice. The pancake ice was often seen a few hours after a calm, covering leagues of ocean, and uniformly stained brown from the attendance of these plants. It was taken in buckets, and when removed from the water appeared perfectly pure and colorless. On melting, however, it deposited a pale red, cloudy precipitate, excessively light, consisting wholly of Diatomaceæ. This precipitate was bottled on the spot, and proved more rich in species than any of the other collections. The specimens were also the best preserved: for Prof. Ehrenberg observes that

some thus obtained appeared as if still alive, though collected three years previous to his examination, and subject to many vicissitudes of climate. The snow sometimes falls on the surface of the still ocean water and does not freeze, but floats a honey-like substance, often called brash ice; treated in the same way as the pancake ice it yielded an abundant harvest. 7. The mud and other soundings from the bottom of the ocean, when brought up on the arming of the deep sea lead, or by the chlam or dredge, generally contain the siliceous skeletons or coatings of many species, with the markings on their surface retained. The soundings were invariably in greenish mud, into which the lead sometimes sunk for two feet. At times this mud seemed almost wholly composed of Diatomaceous remains. 8. The fresh and salt waters and muddy estuaries of the Falkland Islands, and similar localities, present us with species, recurring under circumstances altogether similar to what accompany their allies in Europe.

"The universal existence of such an invisible vegetation as that of the Antarctic ocean is a truly wonderful fact, and the more from its not being accompanied by plants of a high order. During the years we spent there, I had been accustomed to regard the phenomena of life as differing totally from what obtains throughout all other latitudes: for every thing living appeared to be of animal origin. The ocean swarmed with mollusca, and particularly entomostracous crustacea, small whales and porpoises, the sea abounded with penguins and seals, and the air with birds: the animal kingdom was ever present, the larger creatures preying upon the smaller, and these again on smaller still; all seemed carnivorous. The herbivorous were not recognized, because feeding on a microscopic herbage, of whose true nature I had formed an erroneous impression. It is therefore with no little satisfaction that I now class the Diatomaceæ with plants, probably maintaining in the south polar ocean that balance between the animal and vegetable kingdoms which prevails over the surface of our globe. Nor is the substance and nutrition of the animal kingdom the only function these minute productions may perform; they may also be the purifiers of the vitiated atmosphere, and thus execute, in the antarctic latitudes, the office of our trees and grass turf in the temperate regions, and the broad leaves of the palm, &c., in the tropics. * * * *

"I shall now notice the most remarkable feature in the distribution of these organisms. They possess more than ordinary interest, many of the species being distributed from pole to pole: while these, or others are preserved in a fossil state, in strata of great antiquity. There is probably no latitude between Spitzbergen and Victoria Land where some of the species of either country do not exist. * * * * The siliceous coats of species

only known living in the waters of the south polar ocean have, during past ages, contributed to the formation of rocks; and thus they outlive several successive creations of organized beings. The Phonolite stones of the Rhine, and the Tripoli stone contain species identical with what are now contributing to form a sedimentary deposit (and perhaps at some future period a bed of rock), extending in one continuous stratum for four hundred measured miles. I allude to the shores of the Victoria Barrier; along whose coast the soundings examined were invariably charged with Diatomaceous remains, constituting a bank which stretches 200 miles north from the base of Victoria Barrier, while the average depth of water above it is 300 fathoms, or 1800 feet.

"Again, some of the antarctic species have been detected floating in the atmosphere which overhangs the wide ocean between Africa and America. * * *

"The existence of the remains of many species of this order (and amongst them some antarctic ones) in the volcanic ashes, pumice, and scoria of active and extinct volcanoes (those of the Mediterranean sea and Ascension Island for instance) is a fact bearing immediately upon the present subject. Mt. Erebus a volcano 12,400 feet high, of the first class in dimensions and energetic action, rises at once from the ocean in the 78th degree of south latitude, and abreast of the Diatomaceæ bank, which reposes in part on its base. Hence, it may not appear preposterous to conclude that, as Vesuvius receives the waters of the Mediterranean, with its fish, to eject them by its crater, so the subterranean and subaqueous forces which maintain Mount Erebus in activity, may occasionally receive organic matter from this bank, and disgorge it, together with those volcanic products, ashes and pumice."

In the descriptive portion, it should be mentioned that Dr. Hooker, although himself no mean proficient in Cryptogamic botany, especially in Muscology, has received the valuable assistance of some of the best Cryptogamists of the age in the elaboration of the large part of this work which is devoted to these lower orders; Mr. Wilson having been associated with him in the preparation of the Mosses; the late Dr. Taylor, in that of the Hepaticæ and the Lichenes; Mr. Berkeley in the Fungi; and Professor Harvey in the Algæ. Making due allowance for all this important aid, we are more and more surprised at the amount of the results here embodied and the thoroughness with which they have been elaborated; the labor, enough as it would seem for a life-time, having been performed in the course of a few short years. May he long continue, in the new scientific undertakings in which he is at present so zealously engaged, to add new lustre to the honored name he bears.

Art. XIII.—*On the Quantitative Separation and Estimation of Phosphoric Acid;* by H. Rose.*

The second No. of the Annalen der Physik und Chemie for 1849, contains an elaborate and most valuable memoir by H. Rosè on the quantitative separation and estimation of phosphoric acid. As this memoir furnishes the complete solution of one of the most difficult problems in analytical chemistry, we here offer a brief abstract of its contents. Some of the facts in relation to the action of the alkaline carbonates upon the phosphates of lime and magnesia will of course be familiar to many readers; still it may not be improper to mention them as the whole subject is discussed in the original memoir.

1. Phosphoric acid existing in a solution uncombined with bases is best determined by adding a weighed portion of oxyd of lead, (freshly ignited,) evaporating to dryness, and igniting. No bases must be present and no acids which cannot be completely expelled from the oxyd of lead by heat. The application of this method is independent of the particular modification in which the phosphoric acid may exist.

2. In determining phosphoric acid by means of magnesia and ammonia, it is indispensable that the acid be present in the C. modification. After adding sulphate of magnesia, ammonia and chlorid of ammonium, the solution may be gently warmed (as high as 30° C.) and after several hours filtered. The resulting phosphate of ammonia and magnesia is to be washed out with ammoniacal water in the manner recommended by Fresenius. A solution of carbonate of ammonia cannot be substituted for the pure alkali in this process.

3. Phosphoric acid cannot be perfectly separated from peroxyd of iron by means of sulphuret of ammonium, as has been heretofore supposed. The resulting sulphuret of iron contains indeed no traces of phosphoric acid, but on the other hand the precipitated phosphate of magnesia and ammonia is not free from oxyd of iron.

4. Berthier's method of separating phosphoric acid from basic oxyds (by adding a solution of peroxyd of iron and afterward ammonia) does not give satisfactory results in quantitative analyses.

5. Von Kobell's modification of Berthier's method (by means of carbonate of baryta and solution of peroxyd of iron) gives good results in cases where the basic oxyds are not precipitated from their cold solutions by the carbonate of baryta alone.

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* Condensed for this Journal by Dr. Wolcott Gibbs.

6. The C. modification of phosphoric acid may be separated from magnesia by dissolving the phosphate in chlorohydric acid, adding carbonate of baryta and allowing the whole to stand for some time. The supernatant liquid contains all the magnesia, while the phosphoric acid unites with the baryta.

7. The phosphates of lime, baryta, strontia and magnesia, are not completely decomposed by fusion with alkaline carbonates, but if the phosphate of magnesia be fused with six times its weight of carbonate of soda the resolution is very nearly complete.

8. Phosphate of magnesia may be perfectly decomposed according to Weber by fusion with a mixture of equal equivalents of the carbonates of soda and potash. The same however is by no means the case with the phosphates of lime, baryta and strontia.

9. Phosphate of lime cannot be decomposed by fusion with hydrate of potash, or by boiling with a solution of carbonate of soda. If the phosphates however have not been previously ignited, the decomposition is nearly complete in a cold concentrated solution of the alkaline carbonate.

10. The phosphates of zinc, protoxyd of manganese and peroxyd of iron may be perfectly decomposed by simple fusion with carbonate of soda. The phosphate of oxyd of copper is partly reduced to a suboxyd, which however appears to contain no phosphoric acid; on the other hand the solution filtered off from the insoluble residue still exhibits traces of copper.

11. The phosphates of the oxyds of uranium and chromium may be completely decomposed by fusion with a mixture of carbonate of soda and cyanid of potassium. (For the details of the method we must refer to the original memoir.)

12. The phosphates of magnesia and soda cannot be completely decomposed by means of sulphuric acid and alcohol. On the other hand, it is well known that in this manner the separation of phosphoric acid from lime may be easily and perfectly effected.

13. The phosphates of alumina and peroxyd of iron do not admit of a perfect decomposition by means of sulphuric acid and subsequent addition of sulphate of ammonia and alcohol. The phosphate of magnesia may however be decomposed in this manner, though a small portion of the phosphoric acid is always volatilized by heating with sulphuric acid, hence the method is not to be recommended.

14. The following is the method recommended by Rosè for the separation of phosphoric from all bases. The phosphoric acid combination is to be dissolved in a moderate quantity of nitric acid, and the solution brought into a porcelain capsule. Metallic mercury is then to be added in such quantity that a small portion always remains undissolved by the free acid, and the whole

is to be evaporated to perfect dryness in a water bath. If the mass still smell of free acid, water is to be added and the solution is again to be evaporated to dryness. This process must be repeated if necessary till the dry mass no longer smells of nitric acid. Either hot or cold water may then be added, and the whole may be filtered, care being taken to use the smallest possible filter. The mass upon the filter is then to be washed out, till a few drops of the filtrate evaporated upon platina foil no longer leave a residue after igniting the foil. The filtrate now contains the bases united to nitric acid, together with much nitrate of suboxyd of mercury and a small portion of nitrate of the protoxyd. Chlorohydric acid is to be added and the precipitate if abundant is to be filtered off. It consists of Hg_2Cl and should leave no residue after ignition. If however the precipitate obtained by muriatic acid be insignificant, ammonia may be directly added and the partly black and the partly white precipitate obtained must then be rapidly filtered and protected as much as possible from the air during the washing, in order that no carbonate of lime may be formed. This method of getting rid of the mercury can be employed only when there are no bases present which are precipitated by ammonia. Chlorid of ammonium may be added to prevent the precipitation of magnesia. If the decomposition of the phosphates has been complete, the precipitate upon the filter will be entirely volatilized by heat or leave at best a few milligrammes of oxyd of iron. If however this be not the case the process has not been carefully conducted or the whole of the excess of nitric acid has not been driven off. The residue is then to be farther examined; if it consists of earthy phosphates, these may again be decomposed by nitric acid and mercury; if of earthy carbonates or of oxyd of iron, these may be dissolved in chlorohydric acid and added to the filtrate obtained by ammonia. From this filtrate the bases may then be separated in the usual manner.

Instead of separating the mercury from the solution of the bases by means of ammonia, it is frequently more simple and advantageous to evaporate the whole in a platinum capsule and then to ignite the residue in a platinum crucible. In this manner we avoid the necessity of subsequently driving off the large mass of ammoniacal salts formed in the process first described. If however nitrates of the alkalies be present as well as those of the alkaline earths, small quantities of solid carbonate of ammonia must be added from time to time during the process of ignition to convert the decomposed alkaline nitrates into carbonates, otherwise the platinum crucible will be attacked. The ignited residue is to be dissolved in chlorohydric acid and the bases separated from each other in the usual order. It now remains to determine the quantity of phosphoric acid in the residue insoluble in water.

This residue consists of phosphate and nitrate of suboxyd of mercury and of metallic mercury. The filter with the mercurial salts is to be thoroughly dried; the mass is to be carefully separated from the filter, brought into a platinum crucible, and mixed with an excess of carbonate of soda, or still better, with a mixture of equal equivalents of the carbonates of soda and potash, as this is more easily fused. The filter is to be rolled up into a ball, laid in a cavity in the mixture in the crucible, and covered with a layer of the carbonates. The whole is then to be moderately heated under a flue not however to ignition, the contents of the crucible not being allowed to fuse and the heat being continued about half an hour. In this manner the metallic mercury and the mercurial salts, with the exception of the phosphate of the suboxyd, are volatilized. The crucible is now to be subjected to the strongest heat of a spirit lamp with a double current of air and strong alcohol; the fused mass is to be treated with hot water, in which it should be perfectly soluble if the operation has been carefully conducted and if no iron were present in the original compound. The solution is to be supersaturated with chlorohydric acid and the phosphoric acid determined by means of ammonia, sulphate of magnesia and sal-ammoniac.

"By the method described," says Rosè, "all phosphoric acid compounds may be so completely decomposed that, on the one hand, all bases may be obtained free from every trace of phosphoric acid, on the other hand, the phosphoric acid is perfectly separated from all the bases with which it was united, which cannot be effected by any other method."

The following precautions must be carefully observed in the analysis of phosphates by this process. So much metallic mercury must be added to the nitric acid solution, that a distinctly recognizable quantity of the metal remains in the dry evaporated mass. The evaporation must be effected in a water bath and not by the direct application of heat, as in this case portions of the nitrates formed might be decomposed. The nitrates of the stronger bases are not decomposed under the temperature of boiling water. If however alumina or peroxyd of iron be present, the process must be slightly modified as the nitrates of these bases are partially decomposed during the evaporation, and the bases themselves remain upon the filter with the salts of suboxyd of mercury. When iron alone is present, the subsequent fusion with the alkaline carbonate effects its perfect separation, if however alumina be also contained in the mass upon the filter, it will be necessary during the fusion with the carbonates to add silica in the manner recommended by Berzelius. If the heating in the platinum crucible previous to its ignition has not been carefully conducted, oxyd of platinum will be mixed with the oxyd of iron and may be separated from this by dissolving the mass in chloro-

hydric acid and adding excess of ammonia, the platinum then remains in solution while the iron is precipitated as oxyd. Alumina has not yet been detected with certainty in the ashes of organic substances. The assertion of Fresenius that phosphate of peroxyd of iron cannot be perfectly decomposed by fusion with an alkaline carbonate is, according to Rosè, incorrect.

ART. XIV.—*Abstract of an Article on the Conducting Powers of the Metals at different temperatures, &c.;* by M. EDMOND BECQUEREL.*

AFTER an introductory view of what has been done by others on the subject of conducting powers, the author proceeds to introduce a description of the apparatus employed by himself in his researches on the conducting powers of the metals, remarking that it is similar to that employed by the elder Becquerel, but has some modifications which he thinks frees it from all source of error.

The galvanometer employed was a differential instrument, having two separate wires in its coil, these wires being first covered with silk and twisted together into a cord, after the manner of Poggendorff, before being coiled on the frame of the galvanometer. If these two wires be made parts of two distinct metallic conductors of equal conducting power connecting the poles of the same galvanic pair or battery, and so that the two currents shall be in opposite directions through the galvanometer, the needle of the latter will be stationary, and this is the test of the equality of the conducting powers of the two conductors. Of one of these conductors, Wheatstone's rheo-stat is made to form a part of the other wire to be submitted to experiment, so that if any addition be made to the length of the latter included in its circuit, a corresponding addition must be made to the length of the wire of the rheo-stat included in its circuit, in order to maintain the equilibrium of the needle. Thus if after the needle has been brought to rest, one additional metre of the wire of experiment be brought into the circuit, it will be necessary to turn the rheo-stat till such an additional length of its wire is brought into the circuit to which it belongs, as is equivalent in its resistance to conduction to the metre of the wire of experiment. Thus the rheostat is made to furnish a measure of the resistance to conduction of a given length of wire. The apparatus was arranged so that scarce any change was made in either circuit, beyond that of the

* From the Ann. de Ch. et de Ph., 3d series, vol. xvii, p. 242.

length of the included portion of the wire, the nature of the connections remaining the same, and the variations in the length of the wire of experiment could be read off on a graduated scale.

As a test of the accuracy of the method, we give the results of experiments made on an iron wire of a diameter of 0·3223 mm at the temperature of 12°·5 C. These results are cited by the author to prove the law, almost axiomatic indeed, that the resistances are proportional to the length of the wire.

Readings of graduated scale.	Readings of index of rheo-stat.	Lengths of standard wire of rheo-stat.	Lengths of standard wire equivalent to 0·01 m of the iron wire.	Second column calculated by least squares.	Errors of second column.	
Centimet's						Length of
0	94·4	·0	. .	95·9	−1·5	standard
20	257·0	162·6	8·13	256·7	+0·3	wire equiva-
40	419·6	325·2	8·13	417·6	+2·0	lent to
60	579·4	485·0	8·08	578·5	+0·9	0·01 m of the
80	737·7	643·3	8·04	739·3	−1·6	iron wire
100	900·0	805·6	8·06	900·2	−0·2	8·043.

The numbers in the columns following the first are to be regarded as arbitrary units of the standard wire, the unit being nearly equal to 2 mm. The fifth and sixth columns we have added to exhibit the degree of precision of the experiments, and the best result as shown by the numbers in the fifth column is that the resistance of one metre of the iron wire is equal to 804·3 divisions of the rheo-stat, and this is denominated the *equivalent of resistance* for one metre of the iron wire.

The next inquiry considered is whether the relation of the resistance to the diameter follows the commonly received law with the same degree of precision. Two iron wires unannealed, having diameters of 0·7370 mm and 0·3037 mm, gave on a mean of two experiments with each, the following results, the length being one metre.

	Equivalent of resistance.	Diameters.	Squares of the diameter.	Prod. of squares into resistances.
1st wire,	157·08	0·7370	0·5432	85·717
2d wire,	928·65	0·3037	0·0922	85·622

The close correspondence of the numbers in the last column, though exactly what might be expected in conductors of the same metal in the same state of aggregation, is yet worthy of particular notice in the case of wires. It might be anticipated in view of the violent operation of wire drawing, that the smaller wire would differ so much from the larger in texture and hardness as to cause a decided change in the conducting power, and a marked deviation from the law in question on a comparison of the two wires. But the result shows that in the case of iron at least whatever difference of texture there may be in the two

wires has very little influence on their conducting power, and it has been shown* that bending a brass or iron wire, or even annealing the latter at a red heat, causes also but a slight change in their conducting power. That the annealing does produce a change, however, is shown by the following table, in which we copy the first and last three columns only.

Metals.	Conducting powers at 55° Fah.		Ratio of conducting power of annealed to that of unannealed metal.
	Unannealed.	Annealed.	
Pure silver,	93·448	100·000	1·0701
Pure copper,	89·084	91·439	1·0264
Pure gold,	64·385	65·458	1·0166
Cadmium,	24·574	. .	. .
Zinc,	24·164	. .	. .
Tin,	13·656	. .	. .
Palladium,	13·977	. .	. .
Iron,	12·124	12·246	1·0101
Lead,	8·245	. .	. .
Platinum,	8·042	8·147	1·0130
Mercury, (temp. 57°·2 Fah.)	1·8017	. .	. .

Of the metals named in the above table, we see that silver wire alone has its conducting power altered in any considerable degree by annealing.

The next part of the investigation relates to the conducting powers of the metals at different temperatures. The wire of experiment having had its equivalent of resistance at the atmospheric temperature previously determined, was coiled and introduced along with the bulb of a thermometer into a bath of oil. Two thick connecting pieces of copper, whose resistance to conduction could be neglected in comparison with that of the wire, were connected with the extremities of the latter in the bath. By means of this arrangement immersed in a water bath the increase of the equivalent of resistance in the wire due to heating it from the temperature of the air to the boiling point could be measured with accuracy. To ascertain whether the increase of resistance is proportional to the elevation of temperature, the heated bath was allowed to cool gradually and observations were repeated at intervals. The results of experiments on a wire of iron are given in the following table. The second column of temperatures was calculated from the two extreme temperatures on the basis of the law just stated, i. e., that the increase of resistance for 1° Cent. is constantly $\frac{398{\cdot}0 - 23{\cdot}7}{97°{\cdot}8 - 15{\cdot}0} = 4{\cdot}5205$. This quantity we will call $\frac{dr}{dt}$.

* See this Journal, 2d series, vol. i, p. 239.

Temperatures observed.	Temperatures calculated.	Differences.	Readings of index of rheo-stat.
Fixed at 97°·8 C.	97°·8 C.	0°·00 C.	398·0
Temp. falling.	. .	. .	. .
89°·50	89 ·40	−0 ·10	360·0
86 ·50	85 ·20	1 ·30	341·0
86 ·00	84 ·75	1 ·25	339·0
85 ·00	83 ·87	1 ·13	335·3
78 ·50	74 ·58	3 ·92	293·0
74 ·00	70 ·30	3 ·70	273·5
70 ·00	65 ·90	4 ·10	253·6
65 ·00	60 ·80	4 ·20	230·6
59 ·00	55 ·80	3 ·20	207·6
58 ·00	55 ·00	3 ·00	204·4
54 ·50	51 ·64	2 ·86	189·5
50 ·00	47 ·40	2 ·60	170·0
36 ·60	34 ·75	1 ·85	113·0
24 ·00	23 ·63	0 ·37	62·7
23 ·00	22 ·70	0 ·30	58·5
18 ·10	18 ·54	+0 ·44	39·7
15 ·00	15 ·00	0 ·00	23·7

The author considers these results as justifying the conclusion that $\frac{dr}{dt}$ is constant, and ascribes the differences in the third column to inequality of temperature in the oil bath, a bad conductor of heat, during the cooling. To this inference we object, because in the first place there is no presumption in the nature of the case that $\frac{dr}{dt}$ is constant for different temperatures, and in the second place, the equality of temperature being well established at the upper limit of 97°·8 C., the differences in question ought, if they depended on inequality of temperature, to have been greatest in the first and most rapid stages of the cooling, whereas the differences are then very small. We therefore regard these residuals as indicating for $\frac{dr}{dt}$ a variable value containing terms of the first and even of the second powers at least of the elevation of temperature above 0°· C. For practical purposes indeed the variation of $\frac{dr}{dt}$ may perhaps be neglected. For purposes of exact science so far as appears from the paper before us, it certainly cannot be.

Proceeding on the principle that $\frac{dr}{dt}$ is constant, experiments were next instituted on the different metals. An annealed silver wire gave $\frac{dr}{dt}=0{\cdot}4444$, the whole resistance at 12°·75 C. being 116·184. Hence we have,

Increment of resistance for 1° C., . .	0·4444
Whole resistance at 12°·75 C., . .	116·184
" " " 0° C., . . .	110·518

Coëfficient of the increment of resistance,

$$\text{for } 1^\circ = \frac{0{\cdot}4444}{110{\cdot}518} = 0\,004021.$$

In this manner the following table was constructed, to which we add a column for use with Fahrenheit's thermometer.

	Coëfficient of increment of resistance for 1° C.	For 1° Fah.
Mercury,	0·001040	0·000578
Platinum,	·001861	·001034
Gold,	·003397	·001887
Zinc,	·003675	·002042
Silver,	·004022	·002234
Cadmium,	·004040	·002244
Copper,	·004097	·002276
Lead,	·004349	·002416
Iron,	·004726	·002625
Tin of commerce,	·005042	·002801
Tin, purified,	·006188	·003438

From this table and that of the conducting powers before obtained, is constructed a farther table copied into this Journal, 2nd ser., vol. ii, p. 255.

The principal results of the author's researches on the conducting powers of liquids and other later researches connected with the same subject, will be given in the next number of the Journal.

J. H. Lane.

Art. XV.—*A Memoir of Charles Alexander Lesueur.* Read before the American Philosophical Society, at the stated meeting, on the 6th of April, 1849; by George Ord.

At the close of the eighteenth century, the Institute of France, ever actuated by the desire of advancing the sciences, which are the basis of the durable glory of nations, conceived the project of a voyage of discovery in the southern parts of the Eastern hemisphere. Great Britain had done much for geography and navigation. She had recently founded a colony in New South Wales, singular in its conception, unexampled in its success. She was spreading her empire over various parts of Terra Australis, now termed the Fifth Continent; but still there was an extensive field open for geographical enterprise, as a large portion of the southern coasts of that immense country was yet unexplored.

The French government after a succession of extraordinary commotions, now began to assume some consistency; and the nation, always sanguine in its anticipations, hailed the event as an earnest of future prosperity. Bonaparte was elevated to the dignity of first Consul; and although the wars which had called

into activity his military talents still continued, yet was it hoped that under his auspices France, long the antagonist of England in arms, might be enabled to prove herself to be a successful competitor in those pursuits which tend to the improvement and happiness of the human race.

The measure was suggested to the government; and the proposition of the Institute was seconded by the First Consul, who, as a member of the Academy of Sciences, felt a lively interest in its proceedings. The government yielded to the wishes of the Institute; and at the moment when the army of reserve was about to pass the Alps, to enter Piedmont, Bonaparte issued his orders to hasten the execution of this great enterprise.

As it was intended that this expedition should form an epoch in the history of maritime discovery, neither pains nor cost were spared to render it successful. Two sloops of war or *corvettes*, respectively named the Géographe and the Naturaliste, were equipped in the port of Havre; and a selection from the most skillful and experienced officers of the navy was made to conduct them. The scientific corps, with their coadjutors, all of whom had been recommended by the Institute, amounted in number to twenty-three; to wit: four astronomers and hydrographers, three botanists, five zoologists, two mineralogists, four artists, and five gardeners. So large and so efficient a body had never been engaged in a similar expedition.

It was not among the officers alone that there was discrimination in the choice. "The midshipmen before they were received," says the historian of the voyage, "underwent rigorous examinations; the most inferior stations had been sought for with avidity, and some of them were filled by young men of the most respectable families in Normandy, impelled by the desire, peculiar to youth, of acquiring knowledge, and of participating in those distant voyages which ever assume a character of greatness and singularity, and which enforce that respect they constantly merit and obtain. Among these interesting young men was my worthy coadjutor, my estimable friend, Mr. Lesueur, the dear companion of my dangers, my sacrifices and my toil."

Charles Alexander Lesueur was born at Havre-de-Grâce on the 1st of January, 1778. His father, who was an officer of the admiralty, bestowed upon him that education which his limited means afforded; there being several other children that equally claimed his paternal care. In French schools the elements of drawing are usually taught. The bent of the lad's mind being towards this art, his desire to excel in it became a ruling passion, which could not fail to produce the happiest results; and, at the expiration of his pupilage, his parent had the satisfaction of finding, in the productions of his pencil, the skill and finish of a master.

The bold cliffs of Normandy, termed *les falaises*, are remarkable for their savage aspect, and their geological formation. That part of them which forms the Cape *la Heve*, near the entrance of Havre, is the most conspicuous object to the mariner as he approaches the port. The shore, at the base of the Cape, is often frequented by the inhabitants; the youth, especially, resort thither for the purpose of collecting the rejectamenta of the sea; and among the cliffs those wander who take an interest in the singularities of nature, or who are pleased with an extensive prospect. Amid these scenes the boyish days of Lesueur were spent; it was here that he imbibed a love of natural history, augmented by his talents for delineation. It was with a view of the ocean perpetually before his eyes that he cherished those visions of fancy, which were at length realized in his voyage to the southern hemisphere.

It is stated above that among the young men who solicited employment in the expedition was Mr. Lesueur, then in his twenty-third year. The zeal and vivacity which he exhibited were powerful recommendations in his favor, independent of respectable influence; but he was warned of the inconveniences and privations to which he would be liable on shipboard, where every appropriate place was already occupied. He however allowed nothing to daunt him; and he was enrolled among the crew of the Géographe under the designation of *novice-timonier*, which, in English marine vernacular, might be rendered greenhorn or lubber.

In the enumeration of the geologists, it has been said that there were five. In the original plan of the scientific department, it was designed that there should be but four, two in each ship. Ultimately, at the suggestion of the Institute, a fifth was added; and as this individual, during the whole progress of the voyage, performed a most effective part, in conjunction with the subject of this memoir, it becomes proper to state who he was, and what were the motives of the Institute in favoring the application of the supernumerary.

François Péron was born at Cérilly, a town in the Department of Allier, in the year 1775. His father died while he was yet a child, leaving his mother with but slender means, and three children to support. By dint of rigid economy, she was enabled to place him in the college of Cérilly, the principal of which, attracted by his docility, gave particular attention to his instruction, On the termination of his collegiate studies, the ecclesiastical state was suggested to him; but the stirring events of the French Revolution influenced a mind naturally ardent, and he resolved to embrace the military profession. At the age of seventeen he entered the army as a volunteer; and at the battle of Kaiserslautern he was wounded and made a prisoner by the Prussians, who confined him in the citadel of Magdeburg. At the close of the year

1794, Péron was exchanged, and received a discharge from the army, in consequence of having, through his wound, lost the use of his right eye. This misfortune incapacitating him for military service, he resolved to engage in the study of medicine; and, consequently, he repaired to Paris, where he became a pupil of the School of Medicine; and for the space of three years not only assiduously followed the courses of that school, but also those of zoology and comparative anatomy of the museum at the Garden of Plants.

When the expedition for the discovery of southern lands was preparing to depart, Péron conceived a great desire to accompany it, and made application to the government to that effect. He was refused on the plea that, as the scientific corps was already complete, no addition could be admitted. This answer might have satisfied an ordinary applicant, but it was not sufficient for an enthusiastic mind, fertile in resources, and deriving vigor from opposition. He now sought an interview with M. de Jussieu, one of the commissioners who had made a selection of the naturalists, and begged him to intercede for him. To justify his apparent presumption, he stated his views of what he considered an important omission in the scientific department of the expedition. These were urged with a warmth and energy which evidently shewed that he felt himself capable of supplying the deficiency. Let me go, added he, with emphasis, you shall see what I will do! M. de Jussieu, who listened to him with admiration, advised him to write a memoir, explanatory of his motives, in order that they might be made known to the Institute. This course was promptly followed. The memoir, setting forth the importance of associating with the scientific men of the expedition a medical naturalist, one specially charged with the duty of making researches in anthropology, or the natural history of the human race, was read before the Institute; and, on their unanimous recommendation, Péron received the appointment of a place among the zoologists of the expedition, and was ordered to embark in the corvette, the Géographe.

On the 19th of October, 1800, the two ships left the port of Havre, and directing their course for the Canaries, they came to anchor, the beginning of November, in the harbor of Santa Cruz, in the island of Teneriffe. The object of touching at Santa Cruz was to procure certain provisions deemed necessary in tropical climates; which object being accomplished, they took their departure for the Isle of France, where they arrived on the 15th of March, 1801.

Péron and Lesueur, from the commencement of the voyage, seemed to be attracted to each other by mutual sympathy. They were both admirers of nature's works; and perceiving in each other certain qualities which, if properly united, might be pro-

ductive of valuable results, they resolved to labor in concert; and so effectively did they put forth their strength, that they soon became conspicuous to all on board of their ship. The talents of Lesueur, it should seem, were not known, at first, to the artists appointed to accompany the scientific corps; but when these talents were revealed in his masterly drawings of the mollusca and soft zoophytes, with one accord, they pronounced him worthy of a place in their department; and the youthful aspirant was forthwith transferred by the commander-in-chief, from the humble position he occupied among the crew, to the honorable station of painter of natural history, and his appointments and privileges were made to correspond with his rank.

The chief zoologist of the corvette, the Naturaliste, was Bory de St. Vincent, a colonel in the republican army of the west, and well known for his learning and scientific attainments. Shortly after the ships came to anchor in the harbor of Port Northwest, formerly Port Louis, he went on board of the Géographe, to congratulate with his fellow voyagers on their safe arrival. On entering the cabin he perceived several persons looking over the private journal of the commander-in-chief, which was embellished by many beautiful paintings* of fishes, and of those phosphorescent animals which had been objects of uncommon interest to all the naturalists in their passage from Teneriffe to the Indian Ocean. Bory himself was no mean artist; but when he beheld the paintings in question, his admiration burst forth into eulogy, and he inquired who was the author of these master pieces of art, and where he was. "I was introduced," said he, "to a young man of modest demeanor, who, by a noble zeal, had embarked as a *novice-timonnier*, although worthy to form a part of a scientific expedition, in a manner much more useful to the progress of the arts. His talents had been discovered on board of the ship; and the commander-in-chief had availed himself of them by giving him employment. I have been since informed, that strict justice having been done him, his appointments have been assimilated to those of the principals in each department; and he truly merited this encouragement. I sincerely regret that I have forgotten the name of this skillful young man, from whom the expedition must derive one of its greatest resources."†

After a sojourn of six weeks in the Isle of France, the expedition set sail for the coasts of New Holland. They visited those parts named Endracht's Land and Leuwin's Land. Off the coast

* Ce journal renfermait une multitude de figures de mollusques, de poissons, peints avec une perfection et une vérité dont rien n'approche.—*Bory, Voyage*, t. i, p. 161.

† Voyage dans les Quatre Principales Iles des Mers d'Afrique, pendant les années 1801 et 1802. Paris, 1804. 3 vols., 8°, et Atlas, 4°. Tome i, p. 162.

With respect to the commander's journal, report represented it of no value, excepting what was derived from Lesueur's figures.

of the latter, the ships were separated in a violent gale. The Géographe proceeded to the exploration of De Witt's Land; when her stock of provisions and water being nearly exhausted, the commander resolved to depart for the Island of Timor to obtain a supply, and to relieve his crew, dispirited by fatigue and sickness, and thinned by death. On the 21st of August, the ship was moored in the road of Coepang, the chief establishment of the Dutch at Timor. The Naturaliste after her separation explored the coasts of Edel's Land, and rejoined her consort on the 21st of September, in the roadstead of Coepang.

"Perhaps there is no country," says the historian of the voyage, "more interesting, and at the same time, there are few so little known as the great Island of Timor. Placed in the midst of the equatorial regions, covered with the most useful vegetables, and abounding with the most precious animals; intermediate between New Holland and the islands of the great archipelago of Asia, it presents in its atmospherical and geological constitution, in its different productions, and in its physical and political revolutions, important subjects of inquiry and meditation."

Timor afforded a rich field for the naturalists, and their industry was equal to their zeal; but an accident which befel Lesueur, on the 12th of September, nearly cost him his life. While pursuing a troop of monkeys, among the rocks which obstruct the course of the river Coepang, he was bitten in the heel by a venomous reptile. He was alone, at some distance from the town. A numbness, which pervaded the whole leg, was a significant indication of what he had to apprehend from such a wound. He hastened toward the fort, as fast as his condition would permit, as his leg had become rigid. To lessen the activity of the virus, he had recourse to a ligature above the knee; the thigh nevertheless began to swell visibly, and when he reached his quarters, he threw himself upon his bed, overcome with fatigue and agony, and exhibiting symptoms of a malignant fever. The surgeon-major, M. Sharidon, fortunately being at home, immediately cauterized deeply the wound, then applied to it a compress, impregnated with ammonia; he also gave the patient a strong dose of the same, and ordered him to be kept as quiet as possible. A copious perspiration took place, the pains began to abate; and in a few days Mr. Lesueur was enabled to be abroad, with no other inconvenience than a stiffness of the knee, which continued for some time, and was long occasionally felt during sudden variations in the temperature of the weather.

On a superficial view of Timor, it would seem to be an earthly paradise. Nature there exhibits her most inviting forms, and is truly lavish of her bounties. The choicest productions of the tropics there attain to their utmost perfection, and the sea and the land seem to vie with each other in contributing to the gratifica-

tions of man. But there is a counterpoise to these enjoyments in a temperature of the most enervating kind, which deranges the vital functions, and facilitates the approach of that scourge of the Indian isles, the dysentery. The natives of Asiatic descent generally escape this disease, by their habitual use of stimulating food, and that powerful tonic, betel. But the Europeans, and the Americans, who visit those shores, soon become subject to its attacks; and in some instances the entire crews of vessels have been swept off in a few weeks.*

Péron, who paid particular attention to the dietetic habits of the Malays of Timor, and their constant use of betel, became convinced of the influence of condiments and tonics in counteracting the malignant effects of the climate. He hence resolved to conform to customs which were evidently the results of observation; and he owed his preservation from the dysentery to this sensible determination. But his advice and example not being heeded by others, the disease made frightful ravages among the crews of the ships; many of the officers were ill; and of the scientific men nearly the whole were affected by it. The chief gardener died at the island; two of the zoologists, a mineralogist, and an assistant gardener, survived but a short time after their departure. Mr. Lesueur, after recovery from the accident, as related above, pursued his labors with renewed ardor. Péron warned him of the danger of rashly exposing himself in such a climate, without those precautions which the experience of the natives had taught them. But relying too much upon the vigor of his constitution, he at length became a participant of the common calamity. He was still sick when the ships left Coepang; but through the exertions of the physicians, and the unremitting attention of Péron, he was restored to health before their arrival on the shores of New Holland.

It now became evident that a longer stay in that unhealthy climate would occasion the entire destruction of the expedition; hence orders were issued for their departure. On the 13th of November they got under weigh, for Van Diemens Land. Their sojourn at Timor had been prolonged to eighty-four days. "A sacrifice of time," says Péron, "the death of many individuals, the great inconvenience of having on board of the two vessels a large number of sick, were the deplorable results of this long sojourn."

On the 13th of January, 1802, the ships reached the southern extremity of Van Diemens Land, and commenced their explorations of that coast, and the adjacent eastern islands. Off Cape Forestier, the Naturaliste was separated from her consort in a

* Capt. Flinders, in the Investigator, remained only eight days at Timor, and yet, after his departure, the dysentery appeared among his crew to an alarming extent. They got no relief until their arrival at Port Jackson. Some of his best men died.

squall, and the Géographe continued her route alone to the straits of Banks and Bass, and thence to the survey of the extensive region which lies on the southern part of the continent, between Port Western and Nuyts' Archipelago; a country named, by the geographers of the expedition, TERRE NAPOLÉON, on the supposition that they were the first to explore it, not being aware, at the time, that Captains Grant and Flinders had already explored a considerable part of it.*

The accidents and risks, which generally attend a voyage in unknown seas, were fully experienced by our navigators; but dangers, quite as formidable, presented themselves in other forms, those of want and disease. The scurvy, which had succeeded to the dysentery, pervaded the ship, to an alarming extent. "Already," says Péron, "several men had been consigned to the deep; already more than half of our crew were incapable of any duty; and of our helmsmen, two alone could keep the deck. The progress of this epidemic was frightful. Could it be otherwise? Three-fourths of a bottle of fetid water was our daily ration; during more than a year we had not tasted wine; we had not a drop of brandy; and in lieu of these liquors, so indispensable to European seamen, especially in voyages like ours, we were allowed but three-sixteenths of a bottle per man of the detestable rum distilled at the Isle of France, and which there the negroes alone make use of. Our biscuit was full of insects; all our salt provisions were rotten, to the full extent of the term; and so offensive were these meats, that the most hungry sailors, refusing to partake of them, sometimes, even in the presence of the commander, threw their rations into the sea. In short, there were no refreshments of any kind. And those consolations, on the part of authority, so grateful to the feelings of all, so conducive to the alleviation of the most painful privations—these also were wanting. The officers and the naturalists, reduced to a similar allowance with the men, had equal pains to endure both of body and mind."

Winter had now set in, and it became evident that any farther attempts at discovery, at that period, would be abortive, in consequence of their deplorable state. Relief being absolutely necessary, all sail was made for Van Diemens Land; and the ship anchored, on the 20th of May, in Adventure Bay, on the eastern coast of Bruny island, for the purpose of procuring wood and water. A supply being obtained, she departed for New South Wales. Their condition at this time, may be imagined, when it is stated that not a single person was exempt from the scurvy.

* Capt. Grant, of the Lady Nelson, had discovered the eastern part, from Western Port to the longitude 140½°, in the year 1800, before the French ships sailed from Europe; and on the west I had explored the coasts and islands from Nuyts' Land to Cape Jervis in 138° 10′.—*Flinders*, vol. i, 191.

Of the crew, but twelve men, out of one hundred and seventy, were in a condition to do their duty.* They were several days abreast of Port Jackson, totally unable, with all their efforts, to get into port, when they were descried by persons on the look-out for them; and the governor of the colony immediately despatched to their assistance a large boat, containing a pilot, and a supply of men. Had this succor not been afforded them, it is probable that in a short time, all must have perished.

The Naturaliste, after her separation from her consort, off the eastern coast of Van Diemens Land, sought her in vain at the various rendezvous, and at length was compelled to put into Port Jackson for supplies. She had gone to sea in search of the Géographe, when the latter reached the harbor. Much anxiety having been manifested for the safety of the Géographe, in consequence of the known condition of the crew, her arrival was welcomed by all the inhabitants of the colony. The sick were immediately conveyed to the public hospitals, and received every attention which the most refined benevolence could suggest. The governor general gave the French commander to understand that he had received orders from the British government to afford every facility to the expedition in his power; and that consequently not only the public stores should be at his service, but that the bills of the commander, without limitation, should receive the guarantee of the colonial government. "Thanks to assistance so ample," says Péron, "we were enabled to reclothe our crews, who were in want of every thing; to repair our two ships, to purchase a third vessel, and, finally, to resume the continuation of our voyage."

In the mean time, the researches of the scientific men met with universal encouragement. An English guard was mounted to protect their observatory. The naturalists, as well as their assistants, were authorized to carry arms, a privilege not granted to all the inhabitants. Guides and interpreters were appointed to attend them in their distant excursions. "In short," says Péron, "the procedure of the English government here, with respect to us, was so noble, so generous, that to fail in the acknowledgment of our gratitude would prove us to be void of every principle of honor and justice."

The permanent settlement of New South Wales had no older a date than 1788, when visited by the French navigators; and yet, in that short period, the colony had advanced in agriculture, in commerce, and in population, to a degree which excited their admiration. The population, from 1030, carried thither by governor Philip, had increased to upwards of 13,000; and the products of the land not only sufficed for their wants, but afforded a

* Péron, in quoting Baudin's Journal, makes him say *four* men: "Je n'avais plus que quatre hommes en état de rester sur le pont, y compris l'officier de quart." This is evidently a misquotation.

surplus for the maintenance of foreign commerce. "Of all the European nations," says Péron, "that which appears to have best understood the true principles of colonization is the English." We need not go beyond North America to be convinced of this important truth; and when we pass in review the various people who have undertaken to plant colonies on our continents, the Spaniards, the French, the Dutch, the Swedes, and the English; what a cheering subject of reflection is it, that these United States owe their stamina to the Anglo Saxon race; and that their language, their habits, and their characteristics, are those which distinguish the most illustrious nation upon the face of the earth.

A stay of five months duration at Port Jackson, afforded the gentlemen of the expedition abundant means to study the economy and policy of that singular colony; and the results of their investigations, as detailed by Péron, are not only instructive, politically considered, but they impart to his narrative a moral effect, which renders it doubly interesting.

In consequence of the diminution of the crews of the two corvettes, by sickness, death and casualties, it was deemed advisable to send the Naturaliste to France. In her stead a small schooner of thirty tons, was purchased and fitted out as a tender, provided with means to facilitate the labors of the hydrographers, in their explorations of the coasts. She was named the Casuarina.

On the 18th of November, 1802, the vessels sailed from Port Jackson, and directed their course for the Straits of Bass. On the 8th of December, at King's Island, the separation of the corvettes took place; the Naturaliste to pursue her homeward voyage, the Géographe and the schooner to continue those investigations which the disasters of the previous navigation had interrupted.

The Géographe, and her tender, visited in succession the northwest coasts of Van Diemens Land, and the neighboring isles, Napoléon's Land, Nuyts' Land, Leuwin's Land, Endracht's Land, and De Witt's Land. Five months thus employed, amidst difficulties and dangers of no ordinary kind, a want of fresh supplies of provisions and water, compelled them to seek again the Island of Timor, rendered memorable by the calamities of the former visit; and they cast anchor in the bay of Coepang on the 6th of May, 1803. The dreaded dysentery reappearing among them, the vessels were hastily got ready for departure, and on the 3d of June they set sail with the intention of visiting the Land of Arnheim, the Gulf of Carpentaria, and the southwest extremity of New Guinea. After upwards of thirty days of buffeting against the easterly monsoon, the project of continuing their researches appeared to be hopeless, as their stock of water would not suffice for so long a course, and their deadly foe, the scurvy, was once more in the midst of them. The commander therefore resolved to make the best of his way to the only port where the resources

which they stood so greatly in need of, could readily be procured. He was chiefly urged to this measure by his own condition, as he had been, for some time, afflicted with an obstinate spitting of blood. On the 7th of August the Géographe reached the Isle of France, to the great joy of all on board, harrassed by unceasing difficulties, and broken down by sickness and want.

It was now ascertained that the commander's disease admitted of no cure; and on the 16th of September, 1803, Nicholas Baudin ended his days, and was buried with all the honors which were due to the *rank* which he had held in the French navy.

In the composition of the *Etat-major*, or officers of this expedition, there was one capital defect, and that was in the choice of the commander-in-chief. Who Nicholas Baudin was, and what were his claims to that distinction which the government conferred upon him, in appointing him to conduct a voyage of discovery, I have not the means of ascertaining; but judging from the whole tenor of his conduct, as exhibited in the narrative of the expedition, and concurrent testimony, it may be said that a more injudicious selection could hardly have been made. Wanting in that sympathy which is an incentive to the sailor's virtues, he was characterized by fickleness, selfishness, arrogance and malignity. To these repulsive qualities may be added that unbounded self-confidence which is so frequently the concomitant of ignorance. Never, it is probable, having made a passage to the seas of India, and not having profited by consulting the numerous histories of voyages to the eastern hemisphere, he naturally concluded, by the inspection of his chart, that the shortest course to the Cape of Good Hope was the most eligible; consequently, after departing from Teneriffe, he stretched along the coast of Africa, instead of standing to the westward, toward the coast of Brazil, thereby to profit by the trade winds, which prevail in those latitudes. The usual obstacles to the direct route—calms, currents, and baffling winds, at length forced him to change his course. The result of this mistake was the loss of much valuable time, which materially affected the whole plan of the expedition, as, including a stay of eleven days at Teneriffe, the ships were one hundred and forty-five days in their passage from Havre to the Isle of France.

The want of nautical skill in the commander being now manifest, disgust and dissatisfaction were every where apparent. Forty of their best seamen deserted. Several of the officers, midshipmen, and scientific men, resolved to remain in the colony. The principal part of them had the excuse of indisposition; but the true cause was their sense of insecurity with one whose incapacity had already been productive of much evil.*

* Of the scientific corps, there remained in the island, Bissy, astronomer—Michaux and Delisse, botanists—Bory de Saint Vincent, zoologist—and Milbert, Lebrun, Garnier, painters.

The general impression is, that as the post of commander in chief of a scientific expedition is one of great dignity, so, the incumbent must necessarily be presumed to be a man of honor. The French government had omitted nothing which might contribute to the success of the voyage. The magazines of Havre were placed at the disposal of the commander; and large sums of money were granted him for the purchase of medicines, bottled wines, spirituous liquors, soup-cakes, preserved meats, essence of malt; in short, every thing which the health and comfort of man, exposed to the vicissitudes of an extended navigation, could seem to require. But on the arrival of the ships at the Isle of France, circumstances occurred which placed the character of Captain Baudin in no equivocal light. It was observed that upwards of eighty cases and trunks, of what had been supposed to be ship-stores, were landed and given to the care of an individual, who had embarked in the Géographe under the title of captain's secretary, but who, in reality, was a business associate of the commander.* This man at once set up a shop in Port-Louis, for the exhibition and sale of their merchandize, the value of which was estimated to amount to upwards of three hundred thousand francs! So says Bory de Saint Vincent, who declares that he there saw exposed to sale even the ship's medical stores! an act of consummate baseness, which is perhaps without a parallel in the history of maritime discovery.†

The ships had hardly left the Isle of France, when the commander ordered all on board to be put upon short allowance; that is to say, to each man half a pound of fresh bread every ten days. In place of the ration of wine, to which they had been accus-

* In the passport granted by the French government to Captain Flinders, he was expressly prohibited from engaging in any kind of commerce. Baudin, it should seem, had greater latitude in the passport which *he* received from the British government; otherwise he would not have dared to make the scientific character of his expedition a cloak for commercial speculation. "Il est bien entendu cependant, qu'ils ne s'occuperont d'aucune espèce de commerce, ni de contrebande." For a copy of this passport, see "A Voyage to Terra Australis," vol. i, p. 12.

† Je songeai sérieusement à me ménager, pour être rétabli au moment du départ de l'expédition, qui pouvait être prochain. Une bonne santé devenait d'autant plus nécessaire pour continuer le voyage, que nous allions mettre à la voile dans un dénuement absolu de tout ce qui peut être propre à adoucir les dégoûts d'une longue traversée: nos vivres devaient être de mauvaise qualité; nous allions, peut-être aller dans des contrées très-malsaines, et ce qu'il y avait de plus alarmant, c'est qu'il ne restait pas à bord un médicament, en cas qu'il y eût des malades. Sans doute, par quelque méprise, en descendant à terre plus de quatre-vingts malles et caisses marquées B, qui devaient y être déposées, on descendit aussi les médicamens de l'expédition, et même des barils de clous à l'usage du bord; car j'ai, depuis, vu vendre ces objets dans un grand magasin nommè dans ce temps, à l'Isle-de-France, le Magasin des Gabares. Ce magasin, très-considèrable et tel qu'on n'en avait pas vu dans le pays depuis la guerre, contenait pour la valeur de plus de trois cent mille francs de marchandises d'Europe, sur lesquelles on gagna deux, trois et quatre cent pour cent. On disait que ces marchandises provenaient des malles marquées B, qu'on avait débarquées de nos navires.—*Voyage dans les Quatres Principales Îles des Mers d'Afrique.* Tome i, p. 186.

tomed, they were allowed only three-sixteenths of a bottle of tafia.* Buscuit and salt meat were to be their daily food. "A sorrowful prelude to those misfortunes," says Péron, "which afterwards overwhelmed us."

Immediately after the ships had sailed from Timor for Van Diemens Land, a voyage of two months' duration, abundantly supplied with water, the usual ration was curtailed, notwithstanding the remonstrances of the physicians as to the dangerous effect of an inadequate supply, especially to the sick, who were then numerous. Some of the poor sailors, during the tortures of thirst, were induced to drink their own urine!†

Although there was an abundance of ammunition on board of the vessels, the commander, on the pretext of economy, would seldom allow the boats' crew to be armed, and sometimes refused arms to the officers and scientific men, even when the hostile disposition of the natives was manifest. This prohibition of the means of self-defense could admit of no justification; for the commander could not be ignorant of the sad disasters which had frequently been the result of misplaced confidence in the innocence of savages.

Captain Baudin's system of discipline was one of extreme rigidity; hence when parties were permitted to go on shore, or expeditions were despatched on surveys, he was accustomed to prescribe a stated time for their return, without allowance for difficulties or accidents. To insure the fulfillment of his commands, they were furnished with provisions and water sufficient only for the

* About a gill and a half.

† The following observations, in Surgeon White's Journal of a voyage to New South Wales, are worthy of attention.

"Were it by any means possible, people subject to long voyages should never be put to a short allowance of water; for I am satisfied that a liberal use of it (when freed from the foul air, and made sweet by a machine now in use on board his Majesty's navy) will tend to prevent a scorbutic habit, as much, if not more, than anything we are acquainted with. My own experience in the navy has convinced me, that when scorbutic patients are restrained in the use of water (which I believe is never the case but through absolute necessity), and they have nothing to live on but the ship's provision, all the antiseptics and antiscorbutics we know of will avail very little in a disease so much to be guarded against, and dreaded, by seamen. In one of his Majesty's ships, I was liberally supplied with that powerful antiscorbutic, essence of malt; we had, also, sour-krout; and besides these, every remedy that could be compressed in the small compass of a medicine chest; yet, when necessity forced us to a short allowance of water, although, aware of the consequence, I freely administered the essence, &c., as a preservative, the scurvy made its appearance with such hasty and rapid strides, that all attempts to check it proved fruitless, until good fortune threw a ship in our way, who spared us a sufficient quantity of water to serve the sick with as much as they could use, and to increase the ship's allowance to the seamen. This fortunate and very seasonable supply, added to the free use of the essence of malt, &c., which I had before strictly adhered to, made in a few days so sudden a change for the better in the poor fellows, who had been covered with ulcers and livid blotches, that every person on board was surprised at it; and, in a fortnight after, when we got into port, there was not a man in the ship, though, at the time we received the water, the gums of some of them were formed into such a fungus as nearly to envelop the teeth, but what had every appearance of health."—*White's Journal, p.* 34. *London*, 1790, 4°.

computed period of their absence. These restrictions were a perpetual clog to the scientific men, and, in some instances, were near causing their destruction. At Sharks-bay, Endracht Land, a party of sailors, under the command of Lieutenant Montbazin, was ordered on shore, for the purpose of making salt. Péron, Petit the portrait painter, and an assistant gardener, accompanied them, These three started along the coast for the purpose of making collections of natural curiosities. Not returning according to appointment, the officer became alarmed for their safety, and despatched persons in search of them. In the mean time a gun was fired from the ship, for the recall of the boat. This was a moment of anxiety to a generous heart. The search was continued, although two guns more told what were the dictates of the stern commander. At length the poor wanderers, who had missed their way, were found when they were on the point of perishing with fatigue, hunger and thirst: they had not tasted food or water for forty-four hours. Péron could scarcely see or hear, and his parched tongue denied him the use of speech. It was late in the evening when they reached their boat. The supply of provisions was entirely exhausted, and there was not a drop of water left to allay their burning thirst. All night long were they compelled to lie upon the beach, in a state between life and death; and it was not until the afternoon of the following day that they were enabled to rejoin the ship. There were they welcomed, however, with that kindness which compassionate hearts know how to exercise. One individual alone stood unmoved amid the general sympathy, and that one was the commander himself, who, in a tone of unusual asperity, demanded why his orders had not been promptly obeyed. In vain did the Lieutenant attempt to justify his disobedience on the score of humanity; in vain did he point to the pallid countenance, and sunken eyes, of those whom he had rescued from death; his crime admitted of no palliation: he was sentenced to pay a fine of ten francs for each gun fired for his recall; "and this atrocious judgment," says Péron, "he had the audacity to record in his journal! Miserable wretch! in order to save his life at Timor,* I shared with him the small supply of some excellent *quinquina*, which I had reserved for my private use."†

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* The commander's disease was a typhus fever, which reduced him so low, that for several hours he was supposed to be dying. His restoration was owing to a powerful dose of Peruvian bark, which Péron had brought with him from France.

† Parmi les principales causes de nos désastres, il faut compter surtout l'inconcevable opiniâtreté de notre Chef à ne jamais prendre à bord de ses vaisseaux que la quantité de vivres rigoureusement nécessaire pour le temps qu'il se proposait de consacrer à chacune de ses campagnes, sans jamais tenir compte des difficultés ou des obstacles imprévus qui pouvaient en prolonger la durée. Ses mêmes calculs produisaient des résultats non moins déplorables sur nos embarcations; chacune d'elles ne recevait, en partant, que les vivres absolument indispensables pour le

From the commencement of the voyage the commander conceived a rooted aversion to the scientific corps, and missed no opportunity of evincing it by neglect or incivilities. It may be readily conjectured that a man of uncultivated mind would find himself out of place among persons of good breeding, and might seek to console himself for his inferiority, by an affectation of self-sufficiency. He was wont to say, that the Institute had given him *savants* who were of no use to him: all he wanted was *collectors*. His officers, he pretended, would have sufficed for geography and astronomy; and moreover, that he would rather discover a new mollusk than a new island!*

Such discourses as these, mingled with occasional sarcasms, must have greatly tended to wound the feelings of gentlemen, accustomed to the courtesies of society, and to that deference which worth and talents are entitled to. The learned botanist, André Michaux,† was chiefly induced to retire from the expedition at the Isle of France, by the assurance that his services could not be appreciated by one who determined the value of science on the standard of his contracted intellect.

Amid so much opposition, so many trials of body and mind, it is a subject of wonder that the astronomers and geographers of the expedition performed as much as they did.‡ Their labors

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nombre des hommes qu'elle portait, et pour celui des jours qu'ils étaient censés devoir employer à leur mission. Il en était de même pour les divers campements que nous établissions à terre. De là, ces privations pénibles, qui pesaient sur nous à la moindre contrariété que nous éprouvions dans nos opérations générales ou particulières.

Il n'était pas jusqu'au système de distribution de l'eau qui ne fût essentiellement vicieux. Ainsi, pour me borner au cas particulier dont il s'agit maintenant, la ration journalière etait d'une pinte par homme. Cette quantité, déjà si modique pour les individus qui restaient à bord du navire, devenait absolument insuffisante aux besoins des matelots qui, sous un soleil brûlant, devaient ramer quelquefois des journées entières; il en était de même pour les naturalistes, qui, par le genre de leurs recherches, étaient obligés de faire des courses lointaines sur ces plages ardentes. Souvent le cri du besoin, plus impérieux que la voix de la raison, réduisait les plus sobres à consommer, dans quelques heures, ce qui devait leur servir pour plusieurs jours, et à s'abandonner ainsi aux angoisses les plus déchirantes. Il n'était pas, sous des prétextes d'economie non moins funestes, jusqu'aux armes, jusqu'aux boussoles même, qu'on ne refusât souvent à nos embarcations.

Sans doute il est pénible d'avoir de tels détails à rapporter; mais ils intéressent trop essentiellement le succés on même le salut des navigateurs qui doivent courir la même carrière que nous, pour que ce ne fût pas une sorte de crime de les leur taire.—*Péron, Voyage de Découvertes, etc., tome* ii, *p.* 222, *note.*

* Il affecta de publier partout que la moitié des membres de l'expédition étaient inutiles à son succès; que l'Institut lui avait donné des *savants* dont il n'avait que faire; qu'il n'avait besoin que de *rameseurs*, etc. * * * Il prétendait que ses officiers auraient suffi pour la géographie et l'astronomie; et que d'ailleurs il aimait mieux découvrir un mollusque nouveau qu'une terre nouvelle.—*Bory, Voyage, tome* i, p. 189.

† This was the father of the author of the "North American Sylva." He died, not long afterwards, at Madagascar, while engaged in collecting materials for a botanical history of that island. His "Histoire des Chénes de l'Amérique," and "Flora Boreali-Americana," are works of established reputation.

‡ It is but just to add, that they were ably seconded in their explorations by the officers of the ships, particularly by the two Freycinets, and M. de Montbazin.

are an enduring evidence of what may be done by resolute minds under every discouragement. What the naturalists effected, in spite of similar obstacles, shall be related hereafter.

There was one part of Captain Baudin's deportment which is inexplicable, and that was his total disregard of those sanitary instructions, which had been prepared for him by order of the government, especially in reference to means of preventing that dreadful disease, the scurvy. The conduct of Captain Flinders, on this head, affords a striking contrast. Both were engaged in similar explorations in the same seas; both put into Port Jackson for supplies the same season: the crew of one reduced to the extremity of misery by sickness and want, that of the other in such a state of health—every man doing duty upon deck—that their vigor was the subject of general observation.*

The Géographe remained at the Isle of France upwards of four months; and then proceeded homeward. She stopped at the Cape of Good Hope on the 3d of January, 1804. The object of this visit was twofold: to procure fresh provisions, and to take on board for the menagery of the Museum of Paris, some of the rare animals that are indigenous to southern Africa.

While at the Cape, Péron and Lesueur, the last of the zoologists of the expedition, being solicitous of obtaining exact knowledge on the subject of that anomaly in physiology, the *Tablier*, reported as characteristic of the females of a race of the natives of southern Africa; the governor-general, M. de Janssens, and the chief physician of the colony, Raynier de Klerk Dibbetz, lent all the assistance in their power to this end; and the results of their investigations were of a more definite character than those furnished by preceding travellers. This curious organ or appendage, it seems, belongs exclusively to the tribe named *Houswaana* or *Borchisman;* and is never observed in the Hottentots, properly so called. It is visible in infancy; and increases in size with the growth of the body. It disappears by the crossing of the *Houswaana* with other races.†

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* There was not a single individual on board who was not upon deck, working the ship into harbor; and it may be averred that the officers and crew were, generally speaking, in better health than on the day we sailed from Spithead, and not in less good spirits.—*A Voyage to Terra Australis*, vol. i, p. 226, 4°.

† Dr. Alard, in his Historical Eulogy of Péron, thus speaks of the *Tablier*: "Depuis long-temps le tablier naturel attribué aux femmes hottentotes, étail l'objet des raisonnements des physiciens d'Europe et des relations contradictoires des voyageurs. Les uns en niaient l'existence; les autres, tout en l'admettant, le décrivaient de manières tres-différentes. Péron, après des recherches multiplées, reconnait enfin que cet organe singulier n'est ni un repli de la peau du bas ventre, comme on le croyait autrefois, ni un prolongement des grandes lèvres, comme l'a dit récemment Barrow; mais bien qu'il est un appendice particulier tenant par un pédicule à la commissure supérieure des grandes lèvres, s'élargissant et se divisant par le bas en deux branches qui pendent d'ordinaire, mais qu'on peut écarter, donnant ainsi à cette partie une figure triangulaire. Il reconnait que cet organe se trouve l'attribut général et l'un des caractères distinctifs d'une certaine nation sauvage et cruelle, connue des Hol-

It fortunately happened that there were at the public hospital of Cape Town, two females of this extraordinary people, an adult and a girl of twelve or fourteen. These were examined with all that care which so interesting a matter required; and Lesueur's drawings of the *Tablier*, the first, probably, that had ever been made by a competent artist, illustrated two Memoirs on this subject, which were read to the Institute of France in the year 1805. These drawings, four in number, were afterwards engraved; I cannot learn whether or not they have been published. I have in my possession impressions of the plates, presented to me by my ever-regretted friend; and I treasure them as memorials of one, in whose society I have passed many a pleasant and instructive hour.

A stay of twenty-one days at the Cape of Good Hope sufficed for the objects of the visit; and on the 24th of January the Géographe set sail for France. She arrived at the port of Lorient on the 25th of March, 1804, after an absence of upwards of three years and five months. The Naturalist had returned to Havre in June, the preceding year.

Rumors of Captain Baudin's misconduct had affected the public mind, to the prejudice of the expedition; and even the government appeared to regret that the voyage had been undertaken, under the impression, that, as respects its ultimate objects, it had

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landais sous le nom de *Boschismans*, et des Hottentots, sous celui de *Houzouanas*. Les jeunes filles l'apportent en naissant, et il ne fait que croître avec l'âge; il diminue et se perd dans les générations successivement produites par le mélange des *Houzouanas* et des Hottentots ordinaires."

Some three or four years after the publication of Dr. Alard's Memoir, an adult female of this race was exhibited in Paris, where she died in December, 1815. An account of her is given in the "Histoire Naturelle des Mammifères," by the late Baron Cuvier, after an autoptical examination. From this account we extract the following passages.

"Les premières recherches durent avoir pour objet cet appendice extraordinaire dont la nature a fait, dit-on, un attribut spécial de sa race.

"On le retrouva aussitôt; et tout en reconnaissant que c'était *exactement* ce que Péron (Lesueur) avait dessiné, il ne fut pas possible d'adopter la théorie de cet infatigable naturaliste.

"En effet le tablier n'est point, comme il l'a prétendu, un organ particulier; plusieurs de ses prédecessurs avaient mieux vue: c'est un développement des nymphes."

It is much to be regretted, that, as this illustrious naturalist differed in an essential point from Péron, he did not support his opinion by figures of the tablier. Of the accuracy of Lesueur's drawings there is no doubt: it is admitted by Cuvier himself. Must we then conclude that the question is settled? or is it still a moot-point?

The two figures of the Houswaana woman, which accompany Cuvier's essay, by no means correspond with his description; and this is equivalent to the assertion, that they are unnatural or not characteristic. The head, especially, has scarcely a feature of the original. A work, professedly scientific, should seem to require more attention to accuracy.

Among the supplementary plates before mentioned, there is a medallion portrait of the adult female Houswaana, who was examined by Péron and Dr. Dibbetz at the Cape of Good Hope. This miniature was drawn by Nicolas-Martin Petit, from *nature*, with that care and skillfulness which distinguish his works among the illustrations of the "Voyage aux Terres Australes." The configuration of the head is so dissimilar to that of Cuvier's figures, that one would be tempted to believe they were taken from individuals of different races.

turned out to be a failure. On the return to Paris of Péron and Lesueur, they experienced a coldness of reception, on the part of members of the Institute, which sorely afflicted them. In a moment of despondency, Péron was induced to wish that he had never returned. But he soon rallied the forces of his vigorous mind; and waiting upon some of the prominent men of the Academy of Sciences, he begged them to suspend their judgment until the results of the expedition could be ascertained; assuring them of his ability to show, that, notwithstanding all its crosses and disasters, it would not suffer in comparison with any that had preceded it, since the days of Cook and D'Entrecasteaux.

There was but one course for the disheartened naturalists to pursue, and that was an appeal to the fruits of their manifold labors. The collection of upwards of forty thousand specimens of animals, which had been sent home from Port Jackson by the Naturaliste, and the more numerous collection brought in the Géographe, were at the Museum of Natural History, without an indication of their intrinsic value. At the instance of Péron and Lesueur, a committee of the Academy of Sciences, consisting of Messieurs Laplace, Bougainville, Fleurieu, Lacépède and Cuvier, was appointed to examine these collections. In the performance of their duty they made a preliminary report, the tendency of which was to disabuse those public functionaries and Academicians, who had permitted their judgment to be warped by prejudice or misrepresentation. Finally, at the meeting of the Class of Physical and Mathematical Sciences, held on the 9th of June, 1806, a comprehensive report was made, from which the following summary is taken.

"Of the five zoologists appointed by the government, two remained at the Isle of France. Two others perished at the commencement of the second campaign, by diseases contracted at Timor. Péron alone was left; but supported by his invigorated ardor, and the efforts of his coadjutor Lesueur, a zoological collection was made, the extent and importance of which become more and more manifest. It is composed of more than one hundred thousand specimens of animals, several of which will constitute new genera; and the new species, according to the report of the Professors of the Museum, are upwards of two thousand five hundred. If we call to mind that the second voyage of Cook, fruitful as were its discoveries, made known not more than two hundred and fifty new species, and that all the united voyages of Carteret, Wallis, Furneaux, Mears, and even Vancouver, did not produce as great a number,—it results that Péron and Lesueur alone have discovered more new animals than all the traveling naturalists of modern days.

"An imperfect method of description has hitherto greatly impeded the progress of zoological science. Travellers, and espe-

cially several of the Linnean school, have sanctioned this method, because it is easy and expeditious. Limiting themselves to present, in a specific phrase, more or less short, certain characters, omitting a notice of those which, according to this method, were useless for the distinction of the new species from those already known, they thereby obtained only relative descriptions, scarcely sufficient for the wants of Science at the period of their discovery; and which became useless in proportion as new objects required new terms of comparison. Péron has avoided this error; and his definitions, founded upon a general and invariable basis, embrace all the details of exterior organization of the animal, establish all its characters in an absolute manner, and will consequently survive the revolutions of methods or systems.

"A description, nevertheless, how complete soever it may be, can never give a sufficiently just idea of those singular forms, which have no precise term of comparison in objects previously known. Correct figures alone can supply the imperfection of language. Here, the labors of which it is our duty to render an account, acquire a new interest. Fifteen hundred drawings or paintings, executed by M. Lesueur, with extreme precision, reproduce the principal objects which were collected by his careful industry, and that of his friend. All these drawings, either made from living animals or recent specimens, form the most complete and the most precious series of the kind that we have any knowledge of.

"Now we would venture to ask what labor more interesting and complete than that in which is comprised so many important and new animals; than that in which all the circumstances of temperature, of places, of seasons, of habitudes, of food, have been scrupulously observed and collected: wherein all the descriptions have been made from perfect individuals, after a uniform and established method; wherein all the essential objects have been drawn or painted in a natural state, with the greatest exactitude, and in all their details; wherein all these same objects have been preserved with so much care that there are but few of them of which the immediate examination may not serve as a medium of comparison and verification, as well for the description as for the drawing! We do not hesitate to declare that such labors are infinitely superior to all those of the same nature which have hitherto been effected until the present day by any similar expedition, either of our own country or of foreign nations.

"The value of the accession to the Museum of Natural History has been enhanced, not only by the objects presented to Péron and Lesueur personally, by strangers, in the various countries they visited, but even by those which they procured at their private expense, and for the purchase of which they were sometimes obliged to contract onerous debts. They have reserved

nothing for themselves! a proceeding so much the more generous as it is without a precedent among any of their predecessors.

"You have seen by what we have said of the labors of Lesueur, that he was almost every where an associate in those of Péron. The history of Man is not less indebted to him. All the details of the existence of the natives have been designed by him with the most scrupulous accuracy. All their musical instruments, those of war, of hunting, of fishing, their domestic utensils; all the peculiarities of their clothing, of their ornaments, of their habitations, of their tombs; in a word, all that their rude ingenuity has been able to accomplish, is found united in the productions of this skillful and indefatigable artist. The principal site of the coasts explored by the expedition; different views of the town of Sydney, the capital of the English colony of New South Wales, its plan, &c., give to the Atlas of the History of the voyage, edited by his friend, a new character of importance.

"Such are the labors, as numerous as they are interesting, of which you have appointed us to render you an account. They receive additional value from the unfortunate circumstances in the midst of which they were performed. Notwithstanding the foresight and orders of the government, privations of every kind bore heavily upon all the individuals attached to this great enterprise. Diseases extended their ravages among the crews of the two vessels. Of the twenty-three persons presented by you to the First Consul, for divers scientific researches, three only have returned to their native land, after having accomplished the entire voyage. Some, early discouraged, abandoned the expedition; others have remained sick at different places; the remainder are no more. Surrounded by so many disasters, Péron and his constant friend never allowed themselves to be overcome; at every epoch of the voyage they manifested the most honorable attention to their duty."

The testimony of the distinguished men composing the above named committee could not fail to receive the approbation of the government; and shortly after their preliminary report, the Minister of the Marine issued orders for the publication of the narrative of a voyage, that it was now evident would redound to the honor of the nation. And who so fit to edit this important work as he whose talents and industry had been so signally displayed throughout the whole course of the expedition! Péron, then, in the character of historian, set to work with alacrity; and aided by his indispensable associate, Lesueur, arranged those rich materials which appear to such advantage in the first volume of the "Voyage des Découvertes aux Terres Australes."

A remarkable feature in the history of this enterprise presents itself to our reflection. In the composition of the scientific part

of it, no precaution, which an enlightened foresight could suggest to ensure success, seemed to be omitted; and yet, such was the course of events in the department of zoology, one of the prominent objects of the voyage, little would have been done without the efforts of two obscure young men, who had been permitted to embark in the expedition, more with the view of gratifying their importunate desire of seeing foreign countries, than from any expectation of benefit from their services. Without the advantages derived from family connections, from fortune, from reputation, Péron and Lesueur had the bravery to aspire to distinction, and their endeavors were crowned with signal success.

After many difficulties, chiefly resulting from the financial embarrassments of the government, the first volume of the History of the voyage made its appearance in the year 1807; but the Atlas by no means contained as many illustrations as had been prepared for it by Lesueur. This omission was a disappointment to the public, especially to those who had been favored with a view of the invaluable collection of drawings in the possession of the artist, liable to accidents, and the loss of which would be irreparable.*

The constitution of Péron shaken by the trials of the voyage, gave no signs of amendment on his return; and it was not long before it became evident that a pulmonary affection was the cause. His exertions in the performance of his duty, were not relaxed thereby; and his second volume was commenced with unabated zeal, until it was ascertained that he was taxing his mind at the expense of his physical powers, which would ill afford such an expenditure. By the advice of his medical attendants, he was induced to undertake a journey to the southern provinces, not in the expectation of a cure, which he knew was impossible, but in the hope that a more genial climate than that of Paris might tend to mitigate those sufferings which were becoming intolerable. His inseparable friend accompanied him to Nice, where they spent a winter. But it was apparent that a change of scenes, instead of being promotive of repose, so greatly needed, serves merely as a stimulus to exertion. The shores of the Mediterranean presented objects too inviting to be resisted; and Péron engaged anew in those active pursuits, which his feeble body was unable to sustain. On his return to Paris he resumed the narrative of

* When Mr. Lesueur came to America, he brought these drawings with him. It was thought at Paris that they ought to have been deposited in the library at the Garden of Plants; and some feeling was exhibited on the occasion, among the Professors of the Museum of Natural History. In justification of Mr. Lesueur it may be said, that, as it took him the labor of years to furnish these drawings, the greater part of which had been merely sketched during the voyage, and he received no compensation for this extra labor, he consequently conceived he had a right to retain them, as his private property. The remedy for this grievance was very obvious; but the government did not care to resort to it.

the voyage; and had superintended the printing of the thirtieth chapter, when he was warned by the last symptoms of his disease, of his approaching fate. He consequently retired to his native village; where in the bosom of his family, he ended his days, on the 14th of December, 1810, in the 36th year of his age.

The death of Péron, in the midst of his labors, when so much remained to be done, occasioned a suspension of the history of the valuable discoveries which had been made by him and his coadjutor, Lesueur. The regrets of the zoologists of Europe, on this event, might have been spared, had Lesueur been enabled to turn to account the voluminous materials in his possession; for Péron had bequeathed to him the whole of his manuscripts. But the master spirit, who knew how to employ these materials, was no more; and Lesueur shrunk from a task which his disheartened mind felt conscious it was unable to perform.

The duty of completing and publishing the second volume of the history of the voyage now devolved upon Captain Louis Freycinêt, the same who commanded the schooner Casuarina, fitted out as a tender at Port Jackson. The long interval of nine years between the publication of the two volumes should seem to show that more than ordinary embarrassments impeded a work of national importance undertaken by order of the government. The Atlas to the second volume, which appeared in 1816, contains only maps and plans. At least eight and twenty plates, of various illustrations, although finished, were suppressed; and amongst them those before mentioned of the *Tablier* of the Houswaana African.*

Lesueur, accustomed for so many years to an intimate association with Péron, became inconsolable at his death. His usual occupations no longer afforded him that pleasure they were wont to do when there was a kindred mind to participate in them. He would fain have sought in foreign countries, that tranquillity which was not to be found at home; but there were domestic ties to restrain him: his aged father was living and stood in need of his assistance. At length an opportunity was afforded him to gratify his desire for travelling, without inconvenience of a pecuniary nature. Mr. William Maclure, then a resident of Paris, had projected a voyage to the West Indies, and thence to the United States; and made a proposition to Mr. Lesueur to accompany him as a travelling companion. The offer was gladly accepted; and in the autumn of 1815, they departed from France, and arrived at Barbadoes on the 29th of December of the same year. They afterwards visited in succession St. Vincent, St. Lucia, Martinico, Dominica, Guadaloupe, Antigua, St. Christo-

* In the second edition of the "Voyage aux Terres Australes," advertised in Bertrand's catalogue for January, 1831, it is said that there are twenty-five new plates; hence it is probable that those of the *Tablier* were withheld from publication. My supplementary atlas is composed of twenty-eight plates.

phers, St. Bartholemew, St. Eustatia, St. Thomas, St. Johns, St. Croix, with some of the inferior islands. The marine animals of these regions afforded ample employment for Lesueur; and among the fishes and the mollusca he gathered a rich harvest.

In the latter part of the Spring of 1816, Messieurs Maclure and Lesueur arrived in the United States from St. Croix, and immediately set out on their travels through New York, New Jersey, Pennsylvania, Maryland, Rhode Island, Massachusetts, and Connecticut. They finally established themselves permanently in Philadelphia, where Mr. Maclure was formerly domiciliated, when engaged in the active pursuits of a commercial life.

The habits of the Americans, particularly their domestic economy, do not always make a favorable impression upon the mind of a native of France, especially when he comes among us without a knowledge of the English language. Mr. Lesueur, however, had no reason to be dissatisfied with his transatlantic residence. His reputation had preceded him; and the cordial welcome which he received from the most distinguished men of science of the city, could not be otherwise than grateful to one who knew how to appreciate such disinterested kindness. The American Philosophical Society lost no time in enrolling him among its members; and the following year, 1818, he was elected into the Academy of Natural Sciences, and became one of the most efficient supporters of that rising Institution.

The branch of natural history which chiefly attracted the attention of M. Lesueur, when in the United States, was Ichthyology. In Botany and Ornithology much had been done by American Naturalists; but the fishes, which constitute an important item in our commercial statistics, had been in a measure overlooked; at least the few essays which appeared from time to time, on this subject, only served to render the deficiency more apparent. A systematic work, therefore, upon the Fishes of North America, became a leading object with Lesueur; and the means for the accomplishment of it increased so rapidly as to justify the expectations of the friends of natural science of seeing it carried into effect. But a coadjutor was wanting in this enterprise, one whose literary acquirements should enable him to give that consistency to the materials of the naturalist, without which they would be of but little avail. A competent associate, then, not being attainable, the project remained in embryo. A foretaste, however, of these rich materials, was occasionally given in the Transactions of various learned Institutions. Of these opuscules I shall speak in the sequel.

Mr. Lesueur, at the instance of several individuals, who were desirous of profiting by his skill in natural history painting, gave them a series of lessons, at his private residence. He also taught the elements of drawing to the pupils of two respectable female seminaries of Philadelphia. His increased income, by these means,

placed him in that state of independence, which is the cardinal object of every honorable mind.

At length the inclinations of Mr. Lesueur were subjected to a severe trial. After a residence of nine years in Philadelphia, fortunate in a good state of health, happy in an extensive circle of acquaintance, who esteemed and honored him, with active employment for his vigorous intellect and his felicitous pencil,—he was induced by the urgent solicitations of Mr. Maclure, to join the settlement of Socialists at New Harmony, on the Wabash, in the state of Indiana. It was a sense of duty alone which governed him in this determination. If his tastes, if his feelings had been respected, he would have been permitted to remain where his talents had an appropriate field for exertion, and would not have been constrained to forego all the advantages of a well regulated society, for those imaginary benefits to be derived from a condition of association, which had never been subjected to the test of experience. The company of Mr. Thomas Say, at New Harmony, tended to reconcile Lesueur to his lot; and to mitigate that aversion which the discordant elements of the community could not fail to provoke. The two naturalists often made excursions together; and found in the solitudes of the wilderness those consolations which spring from a congeniality of tastes and pursuits. But the attachments of friendship were again destined to be severed. In October, 1834, Mr. Say ended his days; and this deprivation was the more painful to Lesueur, as it seemed to presage the termination of all the plans of scientific enterprise which he had fondly cherished since his residence in the Western hemisphere.

A journey down the Mississippi to New Orleans, served for a while to divert his thoughts from their gloomy forebodings, but failed to suppress them. A return to his native country became the subject of his meditations; still there were difficulties in the way, which, for a time, could not be well surmounted. He retraced his steps, therefore, to New Harmony, and engaged anew in his favorite occupations; but the charm was broken; and he saw no relief for his harrassed mind, but by abandoning a situation which promised advantages that resulted in disappointment and sorrow.

In the year 1837 Mr. Lesueur bade a final adieu to the Wabash and directed his course to New Orleans. There he embarked in a vessel bound to France; and after a prosperous passage, the high coasts of Normandy, the remembrances of happy days, were visible in the horizon. It is for him who has long been a sojourner in distant lands, to judge of the feelings of one who revisits his native country, after an absence of two and twenty years. The heart of Lesueur was formed of the softest mould; and when the turrets and steeples of his beloved Havre greeted his view, his emotions, expressed by his tears, showed that time had neither diminished his patriotism, nor chilled the sensibility of his soul.

In the month of September, 1838, the writer of this Memoir visited Paris; and had the happiness of embracing his old friend, whom he had not seen for thirteen years. Mr. Lesueur was then residing at No. 16, Rue Neuve St. Etienne, not far from the Museum of the Garden of Plants. He had brought from the United States a valuable collection of specimens of natural history; and all his precious drawings and manuscripts, the fruits of his researches in his voyage with Péron, and those subsequently made in the West Indies, and on the continent of North America. Perhaps no individual then living possessed a greater fund of materials for works of the highest interest in natural history; materials destined, in a great measure, it is feared, to be useless, for the want of that mind which alone could direct their application.

Sometime in the year 1843 or 1844, the project of founding a museum of natural history in the city of Havre, was set on foot; and Mr. Lesueur, who had taken a great interest in the measure, was looked to as one eminently capable of filling an important office in an establishment, which was indebted to his personal exertions for much of its favor with the community. In 1845 he was chosen Curator of the Museum; and he removed to Havre in order to superintend the building, which was advancing towards completion.

On the 9th of May, 1846, he thus writes to me: "I hasten to acknowledge the receipt of your letter of the 13th of April, which reached me via Paris. I am occupied at this time in arranging the collections of our cabinet. As my presence is now essential, I have taken a small country house, not far from Havre. It is situated in a quiet valley, a short distance from the sea, which is visible from our windows. Should you return to France, you must come and stay with us. We have a small chamber reserved for your accommodation. Come without ceremony, and partake of our pottage, which you know is excellent. How rejoiced I should be to see you once more! A little omnibus stops daily at our door, and you would be spared the fatigue of going and coming. Our Museum, with its library, would afford you recreation in town, and when fatigued you might retire to my apartment, so that you need not fear ennui."

The letter from which the foregoing extract is made, derives additional value from the circumstance that it was the last that I ever received from my estimable correspondent, whose life was near its close, although nothing, in his external condition, indicated such an event. It was his practice to set out early in the day from his country residence, for the museum; but on the 11th of December, the weather being unsettled, and feeling himself indisposed, he resolved to remain at home. During the ensuing night he complained of oppression at the breast; and a physician prescribed blisters, without suspecting immediate danger. The disease was beyond the reach of remedy; and he expired on the

morning of the 12th of December, 1846, in the 68th year of his age.

The disposition of Mr. Lesueur was social and amicable; and knowing how to accommodate himself to circumstances, he every where met that welcome which his simple, unobtrusive manners could not fail to secure. Accustomed, from early life, to abstemiousness, his economical habits became confirmed, when the means of indulgence were placed within his reach. But although little inclined to self-gratification, he was liberal to others, even in cases where prudence would justify reserve. On departing from France for America, he placed all his disposable means in the hands of his father, among which resources was included the pension that was granted to him by the French government, after his return from the voyage to New Holland. At the death of his father, which took place not long after his establishment in Philadelphia, an attorney was chosen to manage his pecuniary concerns in France; it being his intention to create a fund, to which he might have recourse in case of need. It does not appear that he gave himself much concern with respect to this agency; and on his return to Paris he had the mortification to find that the agent had betrayed his trust, by appropriating to the use of his own family the entire fund, which amounted to the sum of forty thousand francs! The feelings of Lesueur were sorely tried at this event; and the wrong was the more sensible, as it was perpetrated under the guise of friendship. Notwithstanding this heavy loss, at a time of life too, when the infirmities of age began to be felt, he had still a remnant left, the produce of his industry, which modicum he shared with a brother, whose necessities were greater than his own.

At the base of Cape la Hève there is a small valley, in the centre of which the humble spire of the Church of Saint Adresse strikes the view of the voyager, as he directs his course for the port of Havre. Within the precincts of this rural temple repose the remains of Charles Alexander Lesueur: an appropriate resting place for the ashes of one, who, after many wanderings in distant regions, was permitted by Divine Providence, to breathe his last sigh in the bosom of his family, and amidst those very scenes which had awakened the aspirations of his youthful heart.

It was the design of Péron and Lesueur to publish an extensive work upon the Medusa, after the completion of the History of the voyage to Terra Australis. The death of Péron interrupted the project; but Lesueur subsequently issued a programme of this work, with specimens of the plates engraved and colored after his beautiful drawings. It is probable that the great expense attending such an undertaking, was the cause of its being abandoned.

The following is a list of the writings of Lesueur.

1. In the "Annales du Muséum d'Histoire Naturelle," years 1809 and 1810, volumes 14 and 15, conjointly by Péron and Lesueur:—

Histoire gènèrale et particuliére de tous les animaux qui composent la famille des Méduses.

Sur les Méduses du genre Equorie.

Histoire de la famille des Mollusques ptéropodes.

Histoire du genre Firole.

Notice sur l'habitation des animaux marins.

Notice sur l'habitation des Phoques.

2. In the "Mémoires du Muséum d'Histoire Naturelle," by Lesueur alone.

Tome V, 1819.—Notice de quelques Poissons déconverts, dans les Lacs du Haut Canada, durant l'Eté de 1816.

Tome VI, 1820.—Description de plusieurs animaux appartenant aux Polypiers Lamellifères de M. le Chevalier de Lamarck.

Tome XV, 1827.—Notice sur deux Espèces de Tortues du genre Trionyx de M. Geoffroy Saint Hilaire. Two quarto plates accompany this notice; but the author afterwards published five sheets, containing twelve figures of these Tortoises, folio size, carefully lithographed by himself.

3. In the "Nouveau Bulletin des Sciences, par la Société Philomathique."

Année 1813:—Memoire sur quelques nouvelles espèces d'animaux mollusques et radiaires dans la Méditerranée, près de Nice.

Anneè 1814:—Note sur deux Poissons, non encore dècrits, du genre Callionyme et de l'ordre des Jugulaires.

Sur une nouvelle espèce d'Insecte du genre Cymothoa de Fabricius.

Mémoire sur quelques Flustres et Cellépores fossiles; par MM. Desmarest et Lesueur.

Année 1815:—Mémoire sur l'organisation des Pyrosomes, et sur la place qu'ils semblent devoir occuper dans une classification naturelle. Note sur le Botrylle étoilé; par MM. Desmarest et Lesueur.

Année 1817:—Description de six nouvelles espèces de Firoles observèes, par MM. Péron et Lesueur dans la mer Méditerranée en 1809, et établisement du nouveau genre Firoloide.

4. Journal of the Academy of Natural Sciences of Philadelphia—articles prepared by Lesueur while at Philadelphia.

Vol. I.—Description of six new species of the genus Firola.

Characters of a new genus, (of the family of Pteropode Mollusca,) and descriptions of three new species upon which it is formed.

Description of three new species of the genus Raja.

A short description of five (supposed) new species of the genus Muræna.

Description of two new species of the genus Gadus.

Description of a new species of the genus Cyprinus.

An account of an American species of Tortoise, (*Testudo geographica,*) not noticed in the systems.

A new genus of Fishes, of the order Abdominales, proposed under the name of Catostomus.

Description of four new species, and two varieties, of the genus Hydrargira.

Observations on several species of the genus Actinia.

Description of several new species of North American Fishes.

Observations on a new genus of Fossil shells.

Description of several new species of the genus Esox, of North America.

Vol. II.—Description of a new genus, and several new species of fresh-water Fish, indigenous to the United States.

Descriptions of two new species of Exocetus.

Descriptions of several new species of Cuttle-fish.

Observations on several genera and species of fish belonging to the natural family of the Esoces.

Descriptions of five new species of the genus Cichla of Cuvier.

Description of three new species of the genus Sciæna.

On the Onykia angulata.

Description of a Squalus of very large size, which was taken on the coast of New Jersey.

Vol. III.—Descriptions of several new species of Ascidia.
Description of a new species of Cephalopod of the genus Loligo.
On three new species of parasitic Vermes, belonging to the Linnean genus Lernæa.
Descriptions of two new species of the genus Batrachoid of Lacépède.
Vol. IV.—Description of several species of the Linnean genus Raia, of North America.
Description of several new species of Holuthuria.
Description of two new species of the Linnæan genus Blennius.
Vol. V.—Description of a new fish of the genus Salmo.
Description of four new species of Murænophis.
Description of a new species of the genus Saurus.

Transactions of the American Philosophical Society, new series.

Vol. I, (1818.)—Description of several species of Chondropterygious Fishes of North America, with their varieties.

A celebrated naturalist having expressed an opinion that the cliffs of Normandy were uninteresting, on the score of organic remains; Mr. Lesueur, who was of a different sentiment, undertook an investigation of the stratification of the bluff forming *Cape la Hève;* and his discoveries were of a nature to call the attention of geologists to a locality which had been neglected and decried. In the latter part of the year 1843, he published a sheet, entitled, "Vues et Coupes du Cap de la Hève." This lithographic drawing presents numerous details of uncommon interest; and is a pleasing evidence of the versatility of the talents of the author.

ART. XVI.—*On the Diurnal Variations in the Declination of the Magnetic Needle, and in the Intensities of the Horizontal and Vertical Magnetic Forces;* by WILLIAM A. NORTON, Professor of Mathematics and Natural Philosophy in Delaware College.

[Continued from p. 55.]

BESIDES the phenomena which have now been considered, there are two others, to which the laws of the nocturnal loss of temperature may be conjecturally attributed, viz. 1. The varying humidity of the soil at the earth's surface, attended with a change in its specific heat, and—2. An unequal exchange of heat between the atmosphere and the earth, by contact. That the first of these is to be rejected from the list of possible causes, will be seen at once upon considering that there is no evidence that the law of the continued decrease of the loss of temperature as the night advances, depends upon variations in the quantity of rain. There is no sufficiently general increase of humidity, except from dew, and the film of dew is too slight (as we shall see, not more than $0^{in}\cdot01$, on the average, in July) to produce any material change in the specific heat of an inch, or half an inch, of thickness of the soil. Besides whatever influence may arise from this cause may be set down as an effect of dew.

As for the second of the above mentioned conjectures, the following objections lie against it. In the first place the quantity of heat received from the air by simple contact, when the air is perfectly tranquil, is very small, by reason of its low conducting

power. In the second place, the observations show that, in the calmest nights the diminished fall of temperature after midnight is no less certain, than when the equilibrium of the air is disturbed and different masses are brought successively into contact with the surface of the earth. Again, since this law is observed to hold with respect to the temperature of the atmosphere at the earth's surface, the air, when agitated in contact with the earth, must lose from this cause less and less heat as the night progresses. But this is impossible, since the cooling of the earth's surface, from radiation, goes on uniformly, and thus the difference between its temperature and the temperature of the air would increase, and therefore the cooling, for the same amount of agitation, should increase. In other words, the cooling of the air, attendant upon the same degree and extent of agitation, must be uniform. Unless, therefore, there is generally more wind, or the disturbance of the equilibrium of the air extends to a greater height during the latter than during the fore part of the night, the law above mentioned must have some other cause than that under consideration. Now, as a matter of fact, the observations do not disclose the existence of any general difference, of any amount, between the force of the wind before and after midnight. It appears from the curves showing the variations in the force of the wind at Philadelphia, that there are slight differences, but they sometimes lie in one direction and sometimes in the other.

In view of all that has now been stated, it may be confidently affirmed, that if the cause of the two anomalous facts connected with the nocturnal loss of temperature be any meteorological phenomenon, it must be the deposition of vapor from the atmosphere in other forms than that of rain, and chiefly therefore in the form of dew; and it may be stated farther, that either this must be the actual cause, or it must consist in variations in the amount of heat that is returned towards the surface during the night, by conduction from below, or, in other words, in the laws of the earth's cooling at night, irrespective of all atmospheric influences.

This result has been reached, it is true, by taking it for granted that, primarily, it is the temperature of the surface of the earth that varies according to the laws which I have stated, and that the temperature of the atmosphere, near the earth's surface, conforms, of necessity, in its variations, to the same laws, by reason of its relations to the earth's surface. This supposition is in accordance with the notion generally entertained upon this subject, and is not likely to be questioned, but the principles laid down in the general discussion preliminary to the present investigation serve conclusively to establish its truth. For it will be seen that the causes which make the nocturnal radiation from the earth's surface into space and the upper regions of the atmosphere uni-

form, will also tend to make the radiation of the air, in the same direction, uniform, and on a calm night the radiation from the air to the earth ought gradually to increase, inasmuch as the difference of temperature of the two ought slowly to increase, (radiation alone being considered,) and for small differences of temperature the radiation is proportional to the difference. From which it appears that the laws in question are not primarily true of the temperature of the atmosphere.

It was also taken for granted that there was no material variation in the radiating power of the earth's surface from one season to another, by reason of frost or more or less humidity, or changes in the state of vegetation or any other cause. That, in point of fact, the diminished loss of temperature at night in the winter cannot be owing to any such cause as this, will be seen on inspecting the following tabular statements.

Average fall of thermometer from 9 P. M. *to* 4 A. M. *at Philadelphia.*

	1842.	1843.	1844.	Average.
July,	4°·40	5°·35	5°·18	4°·97
August,	....	....	5 ·02	5 ·02
September,	....	....	4 ·84	4 ·84
October,	6 ·00	4 ·04	3 ·77	4 ·60
November,	2 ·57	1 ·55	3 ·40	2 ·50
December,	2 ·61	2 ·43	2 ·01	2 ·35

Mean Diurnal Variations of Temperature at Halle, Göttingen, Padua, and Forth Leith (near Edinburgh.)

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°	°	°
Halle,	4·25	7·59	9·11	14·22	16·79	16·67	16·57	16·05	14·45	12·18	6·21	3·76
Gottingen,	7·16	8·06	12·00	14·94	17·78	17·46	18·02	18·16	17·24	11·55	6·03	4·68
Padua,	6·24	7·27	9·00	9·90	13·68	12·01	16·90	16·31	12·45	8·15	9·31	7·40
Forth Leith,	2·66	3·56	6·15	10·58	8·58	8·33	9·68	7·58	8·04	4·88	4·08	2·30

It will be observed that the nocturnal loss of temperature steadily decreases from August to December, and that there is no cause tending to diminish the radiating power of the earth's surface that operates in the same steady manner at all places, during this interval of time.

I conclude, therefore, that the cause of the nocturnal secondary variations of the horizontal force must either consist in variations in the amount of vapor deposited from the atmosphere, or be in some way connected with the upward flow of heat below the earth's surface. This upward flow of heat is not attended with any variations in the total amount of heat lost, and we therefore can connect the secondary variations with it, only by introducing some new hypothesis. Besides there exist good reasons for believing that it cannot be the cause of the observed variations in the nocturnal loss of temperature, and therefore cannot be the cause of the secondary variations of the horizontal intensity. In the first

place, it appears from equation 4, p. 48, that the loss of temperature at the surface (l), is equal to the entire loss of heat (L) minus the sum of all the losses of temperature of the layers below the surface. It follows therefore, as L is always the same for the same number of hours, that l cannot become less unless the sum of l', l'', l''', &c. becomes greater; now it is a matter of observation that when l is less, l', l'', l''', &c., are also less; the sum of l', l'', &c., cannot therefore be greater in winter than in summer, unless the number of layers which experience a change of temperature during the night increases to a sufficient extent to compensate for the diminished loss of temperature of those nearer the surface. This cannot be the case, for, in the first place the loss of temperature of the lower layers is always comparatively trifling, and in the next place the depth to which any perceptible cooling in consequence of surface radiation extends during the same period of ten or twelve hours, must depend almost entirely upon the length of the interval. Or, we may arrive at the same conclusion in another way. In the month of January the amount of heat gained during the day is lost during the night. The same is true in July. Now the quantities of heat gained during the day are quite different at these two epochs, the one of minimum and the other of maximum temperature, and therefore L must be variable, whereas it is constant. In the next place, although we are in want of the systematic observations of the diurnal variations of l, l', l'', &c., which would enable us to ascertain with certainty whether the sum of l', l'', &c. varied materially during the night or not, and therefore whether the variations of l are attributable to an unequal upward flow of heat; still, if we assume that the established law connecting the total variations of temperature of the different layers, viz., that they decrease according to a geometrical progression for equal increments of depth, is very nearly true for the variations that occur in any given time, and take $\frac{3}{4}$ for the ratio of the progression, (derived from the data on page 45, answering to the depths of 1^m, 2^m, 3^m, &c., taking variation at surface $=15°$,) recollecting that the cooling progresses at the rate of about $1\frac{1}{3}$ inches per hour, we shall find that the sum of the losses of temperature of the layers below the surface up to the hour of 4 A. M. is materially less than twice the sum of the losses up to the hour of 10 P. M.—midway between the hours of maximum and minimum temperature. It can only be made equal to twice this sum by supposing that the fall of surface temperature is increased very nearly in a two-fold proportion—in other words, that it is proportional to the time, or uniform. This result does not depend upon the ratio $\frac{3}{4}$ supposed to be used in the calculation, but upon the fact that the losses of temperature of the new layers below the depth of 8^{in}, or 9^{in}, after 10 P. M., are very small. If it be erroneous, it can only be because the law which I have assumed does not accord with fact. In view

of all these considerations we may conclude, that the notion of a variable flow of heat toward the surface of the earth fails entirely to explain the unequal losses of temperature at night in different seasons of the year, and that it is highly improbable that it has any considerable effect to diminish the losses of temperature from hour to hour during the night. Indeed all known facts connected with the variation of temperature, favor the idea that the laws of the nocturnal variation are the result of some cause at the earth's surface tending to diminish the amount of heat lost there, and producing the same effect as if the radiation varied between certain limits and according to certain laws. This cause can be nothing else than the deposition of condensed vapor from the air in contact with the earth.

Let us now take up the independent inquiry as to what is the testimony of observation and experiment in relation to the variations in the amount of dew deposited in different seasons and in different hours of the night, the actual amount deposited at any one season, and the quantity of heat given out in the condensation of the vapor into dew. I find the following statement with respect to the first of these points, in Lamé's Cours de Physique. "Dew is less abundant before midnight than during the hours which precede the rising of the sun. It is more frequent in spring, and especially in autumn than in summer." I conceive the meaning of the first of these statements to be, that on any individual night when the dew begins to fall early in the evening, it becomes more abundant towards morning. If this be true, it may arise from the fact that there will be sufficient displacement of the air, even on what would be called a calm night, to bring about more or less of an exchange of place between the air resting upon the surface and that which is posited above this; and as the cooling goes on, these various masses brought in succession to the surface will become more and more humid, and therefore more and more likely to deposit a portion of their vapor before they give place in their turn to other bodies of air. Such currents will be established by inequality of surface and of radiation, the irregular action of elevated objects, and perhaps other causes. When the air is perfectly tranquil, the deposition of vapor might increase towards morning by the temperature of the air above the surface becoming reduced below the dew point, in which case a portion of its vapor would be condensed and fall in a fine mist. This undoubtedly sometimes happens, and must be more frequent towards morning than before midnight. But there is another way in which such a phenomenon may be conceived to arise. The air in contact with the earth, and for a certain small distance above it, when dew is being deposited is saturated with vapor. Its temperature is probably somewhat higher than that of the ground, for the variations of temperature of the ground will not be communicated instantaneously to the air just above it. The amount

of dew deposited in any small interval of time will then depend not only upon the reduction of temperature, which takes place in this interval, but also upon the difference of temperature between the ground and the contiguous air, that obtains during this interval. Now, this difference may increase, as the night advances, at the same time that the loss of temperature from radiation continues the same; and the increase may be more than sufficient to compensate for the diminished temperature of the vapor, and thus the dew may be more abundant. It will be seen farther on, that even when a small quantity of dew falls during the night, a portion of vapor is abstracted from the air to the height of several hundred feet. We may learn from this fact that we cannot derive the variations in the quantity of dew from the observed variations in the falling of the dew point, noted only at one particular height. The observations should be made at various heights to furnish the data required for such a calculation.

Whether the fact really be in accordance with our understanding of the statement of Lamé or not, there can be little question that, in the average of weeks and months, there will be more dew deposited after midnight than before; for, besides that we have the authority of Lamé in support of the assertion, it will be observed that it is only when the elevation of the temperature of the air above the dew point at 4 P. M., is equal to, or less than, the amount that the temperature falls in the interval of time between this hour and sundown, that the dew will begin to fall at sundown, and it appears from observation, that at Philadelphia, the difference between the dew point and the temperature of the air, at 4 P. M., is, on the average, about equal to the entire average nocturnal loss of temperature, and is accordingly about 8°, more or less, greater than the fall of temperature down to the time of sundown. Dew must therefore be much more frequent after than before midnight. It is to be observed here, that it is not necessary that the humidity of the air should be above the average, in order that any dew may be deposited during the night, as may perhaps be inferred from the above statement; for, if it were not for the heat given out by the falling dew, the temperature would fall much lower; in other words, the actual loss of temperature is that due to radiation diminished by the heat given out by the condensed vapor.

As to the relative frequency of dews at different seasons, it must become greater, from the very nature of things, for the same loss of heat by radiation, in proportion as the humidity of the air becomes greater; and therefore must increase from July or August to December or January. It is true, that this increased frequency in the occurrence of dew, is partially compensated for by the diminution in the amount of dew deposited from saturated air in a given time, from the same reduction of temperature, as

the mean daily temperature becomes lower; but the effect of this cause is much less than appears at first sight, for, if less dew falls in any short space of time, at the lower temperature, the heat given out will be less, and therefore the cooling will be greater.

We have next to enquire into the absolute amount of dew deposited at any one season. The experiments of Professor Brocklesby, detailed in an article "upon the Influence of Color on Dew," published in the No. of this Journal for September, 1848, furnish data upon which we may base a calculation. The experiments I shall use are a suite of eleven, made at intervals from July 9th to August 4th. Strips of flannel, of the size of from 15 to 17·5 square inches, and of various colors, were placed upon closely shorn turf, or upon a smooth board elevated six or seven inches above the turf, and the amount of dew gained by them ascertained by weighing them. The average amount deposited upon the pieces of green flannel, in the eleven experiments, I find to have been 28·1 grains for a surface of twelve square inches. This is equivalent to a film of water of the thickness of $\frac{1}{1\,8\,8}$ of an inch. The average is very nearly the same for the other colors. It is to be observed with respect to these experiments that they were made at the season of the year when there is the least dew, and that the nights do not appear to have been selected with reference to the degree of humidity of the air, for the amount deposited on the different nights varies from about 20 grs. to 60 grs., and the first ten days are included within a space of twenty days. They were probably a fair average of the nights that occur at that season of the year. The radiating power of mold is 92, and of vegetation over 100, that of lampblack being 100. There is no reason to suppose that the radiating power of flannel is materially greater. I shall therefore consider myself entitled to assume that on clear nights in July the average amount of dew is not less than $\frac{1}{1\,8\,8}$ of an inch.

Connected with the question of the amount of dew is that of the height in the atmosphere to which the abstraction of vapor extends. We may obtain an estimate of the distance through which the vapor falls, by observing how much the dew point falls near the surface of the earth. At Philadelphia, where the hygrometric observations were made at the height of about four feet above the ground, this does not exceed 2°, on the average, in the months of July, August, and September. Obtaining the requisite data, and making the calculation, I find, that to furnish $0^{\text{in}}\cdot01$ of dew at the temperature of 70°, this reduction of the dew point must extend no less than 736 feet; and that this amount of dew is equivalent to all the vapor in the air, when the air is saturated, within forty-three feet of the earth's surface. In the average hygrometric state of the air (for both day and night) it is only half

saturated with vapor, and all the vapor within eighty-six feet of the surface of the earth would not condense into more than $0^{in}{\cdot}01$ of dew, at the temperature of 70°. If we suppose the rise and fall of the dew point, occasioned by winds, to balance each other, then the average fall will represent the excess of the fall attendant upon dew and rain over the rise produced by nocturnal evaporation. The average fall attendant upon dew alone may then exceed 2°; and the withdrawal of vapor extend to a proportionally less height. We may confidently affirm, however, that on a clear night vapor must fall to the earth's surface from a height of several hundred feet. But we are not confined to mere inferential conclusions on this point, for, direct observations upon the varying hygrometric state of the air have been made upon the summits of the Righi and Faulhorn in Switzerland, which have established that even at such heights (4,530 feet and 7,240 feet), the quantity of vapor decreases during the night no less regularly than in the valleys below. But the fall of vapor doubtless occurs at a height much greater than that of the point from which it descends during the night as far as the earth's surface.

What is the amount of heat given out in the deposition of this quantity of dew? The experiments of Watt, and of Clement and Desormes have established that when a given weight of vapor is condensed into water of a given temperature, say 32° F., the quantity of latent heat disengaged is the same, whatever may be the temperature of the vapor, and is sufficient to heat the same weight of water, at the temperature of 32°, no less than 1157°. This then is the amount of latent heat evolved in the deposition of dew on a winter night. On a July night it will be 1119°. We may accordingly assume that all seasons of the year it is more than 1100°; and may therefore conclude that in the deposition of $0^{in}{\cdot}01$ of dew, the heat evolved is sufficient to raise this $0^{in}{\cdot}01$ of water 1100°, and to raise the temperature of one inch 11°. I do not find the specific heat of mold or soil in any table of specific heats in my possession, but in the very extended table given in Pouillet's Elements de Physique Experimentale, I find the specific heat of water set down as much greater than that of every solid in the list. It is therefore highly probable that the specific heat of the soil is much less than that of water. We may strengthen this conclusion, and at the same time obtain some approximation to the element sought, by attending to the specific heats of the principal ingredients of the soil. These are, of silica 0·19, of alumina 0·20, and of carbonate of lime 0·21, that of water being 1. The specific heat of dry soil is therefore probably about 0·20. That of soil in its ordinary moist state must be somewhat greater. A somewhat rough experiment gave me 0·41 for the specific heat of a mass of earth of medium moisture, composed of sand with some clay, the density of which I found to be 1·5.

To be able to determine how much the temperature of a given depth of soil will be raised by a given amount of heat, we must know the specific gravity as well as the specific heat of the soil. Now the specific gravity of sand is stated to be 1·5, that of clay to be 2·2, and that of common earth 2·0. It appears, therefore, that the increased rise of temperature of one inch of soil, above that of water, by reason of the less specific heat of the soil, should be generally pretty nearly counterbalanced by the diminution consequent upon its greater specific gravity. But, as the specific heat is doubtless less than 0·5, while the specific gravity does not exceed 2, the augmentation will be somewhat greater than the diminution, and therefore the heat given out in the deposition of $0^{in}{\cdot}01$ of dew will raise the temperature of one inch of soil more than 11°. If we take the specific heat equal to 0·4, according to the before mentioned experimental determination, and the specific gravity equal to 2, the effect of this amount of heat we find to be 13°·7. Upon a perfectly dry and sandy soil it would not, probably, be less than 36° (since the density would be 1·5, and the specific heat about 0·2). On the other hand, upon a clay soil saturated with moisture, it might be as low as 10°. But I will suppose for the present, that the heating effect of $0^{in}{\cdot}01$ of dew is no more than 11° to one inch in depth of soil, and proceed to enquire what quantities of dew would suffice upon this supposition, to reduce the loss of temperature due to nocturnal radiation down to the actual losses observed in different seasons. On referring to the table of annual variations of temperature at various depths below the earth's surface, given on page 45, we find that the variations at the depths, 1^m, 2^m, 3^m, &c., form pretty nearly a geometrical progression, of which the ratio is about $\frac{2}{3}$,* (the variations continuing below 8^m, and becoming nearly imperceptible at the depth of 18^m). Assuming this law and ratio for the nocturnal variations, at the depths of 1^{in}, 2^{in}, 3^{in}, &c., recollecting that in a night of twelve hours the cooling extends to the depth of about 18^{in}, and taking 12° as the fall of temperature at the surface, which is about the average for the year, and forming the progression, I find the sum of the different terms to be 36°. This then is the actual loss of heat. Now the average fall of temperature at sundown is 2° per hour. If we suppose this to be due entirely to radiation, then, but for the heat given out by the dew, the entire decrease of surface temperature in the course of the night would be 24°; and therefore the entire loss of heat would be $2 \times 36°$ or 72°. To reduce this to 36° the heat given out by the dew must be 36°; and therefore the amount of dew must be about $_{\text{T}}{}^{3}{}_{0}{}^{6}$ of an inch. We have then this result; upon

* The true ratio is between $\frac{2}{3}$ and $\frac{4}{5}$ and nearest to $\frac{4}{5}$. I take $\frac{2}{3}$ in preference to $\frac{4}{5}$, as, for reasons that will appear soon, it will here furnish results nearer to the truth.

the suppositions made the average quantity of dew, for the year, that must be deposited in the interval between 5 P. M. and 5 A. M. to satisfy the requirements of the theory, is about $\frac{3}{10}$ of an inch, and therefore about three times greater than the actual average for July, as ascertained from observation;—or rather, strictly speaking, about three times greater than the average of the results of Professor Brocklesby's experiments, which, it is probable, is somewhat higher than the actual average for this month. On glancing at the curves of diurnal variation of temperature for 1844, (see p. 42,) it will be seen that the average fall of temperature about the time of sundown, varies, from one quarter of the year to another, from $1\frac{1}{2}°$ to 3°. This difference is probably the result of the joint action of three different causes, viz., the unequal evaporation that obtains, at this hour, on some days, the unequal deposition of dew, at the same hour, on other days, and ascensional currents varying in velocity. The first and last, so far as they act, will tend to make the fall of temperature at sundown greater in summer than it would be from radiation alone; and the second tends to make it less than this, perhaps, during the greater part of the colder half of the year. It is probable that the first tendency prevails over the second, and therefore that the average loss of heat, from radiation alone, is not greater than 2° per hour, the average loss of heat at sundown for the entire year. It is certain that it must be less than 3°. On the supposition that it is 3°, the entire loss, from radiation, would be 108°, instead of 72°, and the amount of dew required $0^{in}{\cdot}06$. On the other hand, there can be no question that the estimate I have made of the actual amount of heat lost is too high, for it is the sum of the entire variations of temperature of the different layers, to the depth of 18^{in}, in the course of a day, whereas the actual loss of heat during the night is equal to the sum of the actual losses of the same layers in the course of the night, and the loss of each layer in this interval of time will be less than its entire loss, with the single exception of the layer at the surface. From these considerations it appears that the average quantity of dew necessary to reduce the average loss of temperature due to nocturnal radiation down to the actual average loss, for the year, is certainly materially less than $0^{in}{\cdot}06$, and is probably less than $0^{in}{\cdot}03$. As to the quantities required for the other seasons, taking the radiation at 72°, 15° for the average nocturnal loss of temperature in the interval between the vernal and autumnal equinox, and 9° for the same in the interval between the autumnal and vernal equinox, I find that the heating effects of the dew during the night, in these two periods must be, respectively, 27° and 45°, and the quantities of dew $0^{in}{\cdot}04$, and $0^{in}{\cdot}024$. The average for July, to correspond to an average of $0^{in}{\cdot}024$ for the six warm months, must be less than $0^{in}{\cdot}02$, and probably, judging from the

considerable variations in the amount of dew from March to July, and especially from July to October, noticed by the casual observer, should be less than $0^{in}\cdot01$, and therefore approximate to the actual average for July, which as we have seen is probably something less than $0^{in}\cdot01$. The agreement between theory and observation is therefore as close as it could reasonably be expected to be, in a case in which there is an uncertainty, within certain limits, in reference to some of the numerical results arrived at inferentially, and in which the observations have not all that completeness and definiteness which is essential to a thorough testing of the theory. This is seldom realized except where the observations are made for the express object of subjecting a theory after it has gained a foothold in the region of science, to the most rigid scrutiny.

I conclude, therefore, that the heat evolved from the dew, or condensed vapor, that falls at night, is nearly, if not quite sufficient to reduce the theoretical decrease of temperature due to radiation, down to the amount which actually obtains; and that the variations in the quantity of dew that falls at night, from one season to another, are attended with sufficient variations in the amount of heat imparted to the earth, to effect the changes observed in the nocturnal decrease of temperature during the year.

As to the general explanation of the effect of dew, I conceive that, in the average of months, the amount of dew deposited from hour to hour during any one night, and from night to night, is in proportion to the humidity of the air, and therefore must increase steadily from sunset to sunrise, and from summer to winter. I consider that it has been conclusively established, that it is only from the varying amounts of heat imparted to the earth, consequent upon these varying quantities of dew, that the observed changes in the nocturnal losses of temperature from hour to hour, and from night to night, can possibly result.

(To be continued.)

ART. XVII.—*On the Method of determining the Geographical Longitude by Altitudes of the Moon;* by W. CHAUVENET, Professor of Mathematics in the U. S. Naval School.

THIS method has been proposed for the use of navigators on account of its practicability with the sextant, and the ease with which altitudes are observed with that instrument. It can be of little use, however, at sea, where the uncertainty of the data—the local time, the latitude and the moon's altitude—is such that the result of an observation of this kind could rarely be relied upon within 30′ of longitude.* But on land, with the artificial

* Raper (Practice of Navigation, p. 285) says $\frac{1}{4}$ of a degree.

horizon, it admits of considerable accuracy, and properly computed may be rendered quite as correct as lunar distances. Indeed, as many observers can take altitudes with the artificial horizon more correctly than they can measure the distance of the moon from a star, it may even prove superior to the "lunar." With a view to this application, I propose to point out a slight inaccuracy in the common method of computing the hour angle of the moon from the altitude, to investigate the amount of this error, and to give a more correct process.

The outline of this method is as follows. With the true altitude (a), the declination (δ) and the geographical latitude (φ), the hour angle of the moon (h) is found by the formula

$$\cos. h = \frac{\sin. a - \sin. \delta \sin. \varphi}{\cos. \delta \cos. \varphi} \qquad (1)$$

or
$$\sin. \tfrac{1}{2}h = \sqrt{\frac{\cos. \frac{1}{2}(p+\varphi+a) \sin. \frac{1}{2}(p+\varphi-a)}{\sin. p \cos. \varphi}}$$

where $p = 90° - \delta$.

Then from the known local sidereal time (T) we have the moon's right ascension by the formula $R = T \pm h$; and corresponding to this right ascension, the ephemeris gives the Greenwich time of the observation, and consequently the longitude.

Now in order to compute the formula (1) correctly, it is necessary to allow for the compression of the earth, and in every work upon practical astronomy that I have seen, we are directed simply to reduce the horizontal parallax by a quantity that is proportional to the diminution of the earth's radius at the latitude of the observer, and with this reduced parallax to correct the altitude by the usual methods. If the vertical line of the observer passed through the center of the earth, this process would obviously be correct, but the earth's radius and the vertical, making in general an angle, it involves an error in all cases except when the observer is on the equator, (or at the pole,) or when the moon is on the prime vertical. The amount of this error will be estimated by means of the accurate process, which follows. The principle of this process is familiar to astronomers, from the use made of it by Bessel, but it does not appear to have been applied to this problem.

Let the altitude be reduced to the point in which the vertical intersects the axis of the earth, which for brevity we may designate as the point P; and let the moon's declination be reduced to the same point. Since this point is in the axis, these reductions do not affect the hour angle; and since the zenith is not changed, we still employ the geographical latitude, so that we shall have

$$\cos. h_1 = \frac{\sin. a_1 - \sin. \delta_1 \sin. \varphi}{\cos. \delta_1 \cos. \varphi} \qquad (2)$$

in which a_1 and δ_1 are the altitude and declination reduced to the point P, and h_1 is the true hour angle.

To reduce the altitude to the point P.—After correcting the observed altitude of the limb for the refraction and applying the apparent semidiameter,* we have the altitude a_0 as affected by parallax, to correct for which we employ a horizontal parallax π_1 obtained from the equatorial hor. par. π, by the formula

$$\sin.\pi_1 = \mathrm{B}\sin.\pi \qquad (3)$$

where $$\mathrm{B} = \frac{1}{\sqrt{(1-\varepsilon\varepsilon\sin.^2\varphi)}}, \quad \varepsilon\varepsilon = 0065466$$

and log. B is taken from a table with the argument φ. As this table is not given in works on navigation, we may substitute for formula (3) the following, obtained by developing B;

$$\pi_1 = \pi + \tfrac{1}{2}\varepsilon\varepsilon\pi\sin.^2\varphi + \&c. = \pi + \triangle\pi \qquad (4)$$

The quantity $\triangle\pi$ is very nearly the same with that which is usually given as the "reduction of parallax," so that we may with a slight sacrifice of accuracy, obtain it from a table of reduction, observing however to *add* it to the hor. par. instead of subtracting, as in the usual methods. The parallax in altitude is then $\pi_1\cos.a_0$, whence $a_1 = a_0 + \pi_1\cos.a_0$.

To reduce the declination to the point P.—We have the known relations

$$\left.\begin{aligned} r_1\cos.\delta_1 &= r\cos.\delta \\ r_1\sin.\delta_1 &= r\sin.\delta + ai \end{aligned}\right\} \qquad (5)$$

where r = moon's distance from the center of the earth.
r = " " " point P.
ai = distance of the point P from the center of the earth.
a = equatorial radius.

$$i = \frac{\varepsilon\varepsilon\sin.\varphi}{\sqrt{(1-\varepsilon\varepsilon\sin.^2\varphi)}} = \varepsilon\varepsilon\mathrm{B}\sin.\varphi.$$

From these equations we find directly

$$\sin.(\delta_1 - \delta) = \frac{a}{r}i\cos.\delta_1 = i\sin.\pi\cos.\delta_1$$

or with sufficient accuracy

$$\delta_1 - \delta = \varepsilon\varepsilon\pi\sin.\varphi\cos.\delta \qquad (6)$$

which is the correction to be added (algebraically, observing the signs of φ and δ) to δ, in order to reduce it to the point P.

These computations are extremely simple and scarcely add to the labor of the ordinary methods. As they are not based upon rigorously exact formulæ, however, it is proper to investigate the degree of approximation which they give.

* The apparent semidiameter will be found with sufficient accuracy for the present problem by the usual formula $\varrho' = \varrho(1 + \sin.\pi\sin.a_0)$, where ϱ and ϱ' are the values of the semidiameter for the center of the earth and the observer respectively; but if the square of the parallax is retained in the series and the compression of the earth also taken into account, a small correction will be found which may amount to 0″·38, when the moon is in the zenith.

The expression for the normal (a_1) or the distance of the observer from the point P is

$$a_1 = \frac{a}{\sqrt{(1 - \varepsilon\varepsilon \sin.^2\varphi)}} = \mathrm{B}a$$

whence $\frac{a_1}{r} = \mathrm{B} \times \frac{a}{r}$, or *nearly* sin. $\pi_1 = \mathrm{B}$ sin. π as in formula (3).

Strictly sin. π_1 is not equal to $\frac{a_1}{r}$, but to $\frac{a_1}{r_1}$. To estimate the error we have from the equations (5),

$$r_1 = r + ai \sin.\delta$$

whence

$$\sin.\pi_1 = \frac{a_1}{r_1} = \frac{a_1}{r + ai \sin.\delta} = \frac{a_1}{r} = (1 - \frac{a}{r} i \sin.\delta - \&c.)$$

or with extreme precision,

$$\pi_1 = (\pi) - \pi^2 i \sin.\delta \sin. 1'',$$

so that (π) found by (3) is in error by the quantity $\pi^2 i \sin.\delta \sin. 1''$, the value of which for $\pi = 61'$, $\delta = 29°$ is only $0''{\cdot}21 \sin.\varphi$.

To find the error of formula (6) in which the factor B is assumed equal to unity, we easily find that the maximum value of $\delta_1 - \delta$ is about $25''$, and the value of B lies between 1 and 1·0033, so that the maximum error in $\delta_1 - \delta$ is $25'' \times {\cdot}0033$ or $0''{\cdot}08$.

Finally, *to estimate the error of the common method.*—In this method the hor. par. is reduced by the quantity $\triangle\pi$ of formula (6) and the geocentric declination and geographical latitude are employed in the formula (1). Let α be the altitude that would be obtained by neglecting the compression of the earth, that is, employing the equatorial hor. par. π without reduction; α' that which is obtained by employing $\pi - \triangle\pi$, and α_1 that which is obtained as above, by employing $\pi + \triangle\pi$. Let h, h' and h_1 be the corresponding hour angles. Differentiating (1) taking h and α as variables, we find

$$dh = -\frac{d\alpha \cos.\alpha}{\cos.\delta \cos.\varphi \sin.h}.$$

But $\alpha' = \alpha - \triangle\pi \cos.\alpha$; therefore substituting $d\alpha = -\triangle\pi \cos.\alpha = -\frac{1}{2} i\pi \sin.\varphi \cos.\alpha$

$$dh = \frac{i\pi \cos.^2\alpha \tan.\varphi}{2 \cos.\delta \sin.h}.$$

Again, differentiating (1) taking h and δ as variables

$$d'h = d\delta \left(\frac{\cos.\delta \sin.\varphi - \sin.\delta \cos.\varphi \cos.h}{\cos.\delta \cos.\varphi \sin.h} \right).$$

If M = the angle at the moon included by the vertical and declination circles, we have the relation

$$\cos.\delta \sin.\varphi - \sin.\delta \cos.\varphi \sin.h = \cos.\alpha \cos.\mathrm{M}$$

whence (substituting also the value of $d\delta = i\pi \cos. \delta$)

$$d'h = \frac{i\pi \cos. \alpha \cos. M}{\cos. \varphi \sin. h}.$$

Now

$$h' = h + dh_1, \quad h_1 = h - dh + d'h$$
$$h' - h_1 = 2dh - d'h$$
$$= i\pi \cos. \alpha \left(\frac{\cos. \alpha \sin. \varphi - \cos. \delta \cos. M}{\cos. \delta \cos. \varphi \sin. h} \right)$$

and if A = moon's azimuth, we have the relation

$$\cos. \alpha \sin. \varphi = \cos. \delta \cos. M = \sin. \alpha \cos. \varphi \cos. A,$$

whence

$$h' - h_1 = i\pi . \frac{\sin. \alpha \cos. \alpha \cos. A}{\cos. \delta \sin. h}$$

which by means of the relation

$$\cos. \alpha \sin. A = \cos. \delta \sin. h$$

is finally reduced to

$$h' - h_1 = i\pi . \frac{\sin. \alpha}{\tan. A}.$$

The maximum value of $i\pi = \varepsilon\varepsilon\pi \sin. \varphi = 25'' \sin. \varphi$, so that the error of the common method may be expressed by

$$h' - h_1 = 25''. \frac{\sin. \alpha \sin. \varphi}{\tan. A}.$$

This formula shows clearly enough that the common method is too inaccurate to be generally employed, for the error in the hour angle may even exceed 25″, when the moon is within 45° of the meridian or tan. A < 1. In the problem here considered, however, the error will always be much less, since the observations will always be taken within 45° of the prime vertical, and in many cases upon the prime vertical, when the error will be nothing. This method then might be used in certain cases, but it will be preferable to proceed by the method above given, which is always precise, and requires very little additional labor.

The method of determining the longitude by the moon's altitude has not the advantage which distinguishes moon culminations, occultations, etc., of a direct comparison with similar observations in other places, or the same or nearly the same time, but like the lunar distance, depends principally upon the accuracy of the ephemeris. It must therefore rank as a subordinate method, valuable chiefly to the traveller on account of its practicability with that "portable observatory," the sextant and artificial horizon.

Annapolis, Md., June, 1849.

ART. XVIII.—*On the Electro-Chronograph;* by the inventor, JOHN LOCKE.

1. I PROPOSE first to give some brief definitions of the Electro-chronograph, and secondly to correct some erroneous opinions which have been formed, and some distorted and faulty publications which have been made, with reference to the invention.

2. A very brief though defective definition of the chronograph was suggested by the enquiry of a laboring man of this place. Sir, said he, is it true that you are making *a clock which will make marks on paper a thousand miles off?* This definition is true affirmatively as far as it goes. But the sort of marks and the use that can be made of them are essential points in the subject. It will mark down, at a distance, measured units of time representing truly duration by space. This again falls short of an account of the performance. *It marks time in such a manner as enables an observer, at any part of the circuit, to mark down the exact moment of any event in any other part of the circuit, be it ever so distant, and that too with the facility of a mere touch of the finger.*

3. It is this last item, the manner of the marking, which has been overlooked, and being overlooked has caused learned men and learned bodies of philosophers to pronounce other inventions, as Wheatstone's and Bain's interruptors, or break-circuits, so far as electrical interruption is concerned, to be the equivalents of my own, when really those interruptors could not begin to perform their part of the functions of the electro-chronograph. Introduce either Mr. Wheatstone's or Mr. Bain's interruptor into my chronograph instead of my own and not a single observation could be recorded with it. Prof. Wheatstone and others had special objects in view, and they made excellent inventions to attain those objects. They accomplished what they proposed and I have a high opinion of their merit. But when my own countrymen attribute to them that which they never sought to accomplish, and to which they have no claim, it is evident, even in the most charitable view, that they did not understand the subject which they have been so ready to hand over to foreigners.

4. I will now attempt to point out the peculiarity by which I have made it possible to record the exact time of events (astronomical phenomena) at a distant station by means of a single electrical circuit. The marks are made telegraphically on the distant paper, or other recipient, while the electrical circuit is closed throughout; the least interruption, though it be of the thickness only of tissue paper, stops the marking whether it be with Morse's machine, which traces a groove in the paper by a sharp point, or by Bain's machine which stains or inks a line by elec-

tricity acting on a chemical compound. It is evident that the best imprint which a distant operator can make on this marking machine to indicate an event, is to interrupt or disjoin the circuit, and thus interrupt the line at that moment being generated. Most of the electrical or magnetic clock machines mounted before mine, caused only momentary shocks of electricity, leaving the electrical circuit mostly open and without a current. Had they been connected with either Morse's or Bain's recording instruments, as mine is, the markings would have been dots and blanks, or Prof. Wheatstone's would have marked alternately a line and a blank, the blanks occurring in all cases while the circuit is broken and held open by the clock. Suppose now, while the clock holds the circuit open for a whole second at A, an observer distant a thousand miles at B, wishes to make an observation at C still another thousand miles off, what can he do? He can break the circuit. So he can, but the circuit is already broken by the clocks and breaking it again in another place makes no change, a blank was being generated, and it continues still to be a blank; for when a circuit is broken at one place it is broken in all places, and as regards electrical action it is, for the time being, a nullity—has no existence, and the distant operator can perform no action through it. Such were the instruments of Messrs. Wheatstone, Bain and others, set forth to a limited extent as the equivalent of mine.

5. *The distant operations are confined, necessarily to positive and negative effects, or to lines and blanks, and while the distant clock chooses to hold the circuit open, the operator has no choice, he cannot produce a position, viz., a dot or a line. He is therefore confined to a negative, a blank, which he can command by breaking a circuit otherwise every where closed.* Therefore, *in order to render the recording of observations, in the distantly generated time-scale, possible, it is indispensable that the circuit be kept closed as nearly continuously as possible.* It is a want of attention to the fact that the operator cannot mark lines as well as blanks at pleasure while the clock is operating, which has caused so many wrong and impracticable views to be taken of this question. Such then is the condition of the electrical clock-interruptor which I have invented. It causes the units of time (seconds) to be marked by long lines interrupted by short breaks in order that observations may be recorded by longer breaks, the punctum of the observation being the commencement of the break.

6. As this commencement will sometimes happen within the little break designed to mark seconds, I have devised the Metrotome key, which makes the observation break always of a uniform length, say half of a second, when its commencement can always be deduced from its ending, and whenever that com-

mencement happens in the letter break, the ending will be in the midst of a proper line.

7. That this point of the necessity of a circuit nearly continuously closed, is rather a blind one, is evident from several facts. *a.* I did not perceive it clearly myself without some study. *b.* In my correspondence with Dr. Bache, he suggested that I should improve my invention by marking seconds by dots and blanks, when I explained to him the impossibility of doing so under the conditions assumed, unless by a reverse arrangement, generating blanks while the circuit is closed, a thing possible with Morse's registering instrument, when still the circuit would be as before, mostly closed. *c.* Prof. Mitchel, of Cincinnati, in an attempt to anticipate me in the result of my researches, used an interruptor invented by me three years previous, though I presume unknown to Prof. M., and succeeded in marking dots on a Morse fillet. The interruptor was the pendulum rod swinging, at its lower end, through a globule of mercury, the pendulum and the mercury being connected with the battery poles. When Prof. M. informed me of what he had been doing, for I knew nothing of it until I had finished my invention, I asked him if he had imprinted observations upon this dotted fillet. He answered that he had not, but he thought he could do it. I asked him how. He replied that he would break the circuit. I reminded him that breaking his circuit would merely obliterate his dots, and asked him how he would mark an event which should occur fractionally between the dots. He admitted the impossibility. *d.* Various individuals of good attainments have expressed themselves unable to perceive the peculiarities which I have just described. *e.* One individual expressed his intention of making a clock perform chronographically by means of a dotting register, but in the execution he found the necessity of changing his plan.

When the clock is near the operator so that he can have an extra circuit to it, or when he is at the registering instrument so that he can strike in his observation-marks positively by hand, or by an extra circuit, then a dotting registration can evidently be adopted.

8. By way of further defining the electro-chronograph, permit me to introduce a brief history of the invention from a work which you perceive is printed but not yet published.

My attention was first drawn practically to the subject of the combination of clocks and electrical machinery for producing useful results, in 1844 and '45. I was delivering a course of popular lectures at Cincinnati on Electrology. My object was not so much to reduce any thing to a complete system in actual practice, as to show the essential elements of what was actually practicable. Having commenced and continued my studies of elec-

trology under what are called "disadvantageous circumstances," viz.: without the usual aids of instruments, or of instrument makers, I was under the necessity of devising and making my own apparatus. Under these circumstances, I had accumulated, in the shop room contiguous to my laboratory, a very efficient and perfect set of tools, among which are the lathe and other shop tools made by the distinguished sculptor, Hiram Powers, and used by him while he occupied himself as a mechanic at Cincinnati. Whenever a new principle was announced, I found it better to devise and make the apparatus suited to its illustration than to purchase the stereotyped models often imperfectly planned and worse manufactured. Thus avoiding all servile copying, and venturing almost to avoid the trodden paths pointed out by books, we drank our knowledge as much as possible from the fountain itself, by appealing directly to nature. This course gave a freshness to popular instruction which evidently excited an interest and produced an effect proportionate to the intense toil which its prosecution demanded.

During the winter of 1844–45, I had three assistants, viz.: Thomas K. Beecher, A.M., and my two sons, John Locke, Jr., and Joseph M. Locke, all of whom were extremely expert at acquiring mechanical skill, and all of whom became enthusiastically active in the execution of instruments, which were thus invented, modelled, made, and used by our corps. The exalted character of my audience, composed as it was of men of high attainment, incited us to the utmost exertion, which was at the same time in the highest degree agreeable and yet too severe to be long continued.* It was in this course of lectures, when on the subject of magnetic or electric clocks, that I devised and made two clock-electrotomes, "break-circuits," or electrical "interruptors," which, so far as I know, were new. I used these to show my audience how they might be applied to the several purposes of repeating the beats of a clock and of causing a secondary clock to move without pendulum or weights at telegraphic distances. In one of these, the electrical circuit was interrupted by a conducting pendulum swinging at its lower point, through a little mercury cup; in the other a wheel with pins or teeth tripped a little tilt hammer and broke the circuit, not by friction, but by direct separation of contact and restored it by the reverse motion. I had read the general accounts of the magnetic clocks of Europe and had seen the *details* of some of them,† and I entertained objections to the *frictional* mode of making and breaking circuit,

* That audience included six presiding Judges, the President and officers of the Medical College of Ohio, the Catholic bishop and priests of Cincinnati, the officers and professors of St. Xavier's College, professors and officers of other colleges and institutions of learning, with members of the profession of medicine.

† Bain's for example.

and especially when that friction taxed, either directly or indirectly, the motion or force of the *pendulum;* especially did I consider it incompatible with astronomical clock performance, that the contact should be a direct friction on the pendulum. The above-named elementary inventions remained unapplied until 1848–9.

9. In October, 1848, Coast Surveying Assistant, Sears C. Walker, who had some years been determining longitude by means of electric telegraphs, the "time signals" and "star signals" being made by ordinary clock reading and by manual contacts and breaks of the electric circuit, thereby bringing the distant magnet into visible and audible action, applied to me to improve the means of determining longitude. He pointed out two desiderata—one, *a means by which the clock itself should close and break the circuit, and thus make its beats audible through the means of a distant included electro-magnet*—and the other, *a means by which an observer at one point of a telegraphic circuit of wires might start a clock at repose, at any distant part of that circuit, at any desired moment.*

10. The former, I informed Mr. Walker, had already been accomplished by the magnetic clocks of Europe, a fact of which he did not appear to have been specifically apprised. To accomplish the latter, I devised the means, a thing very easy to be done. I informed him also that I had objections to the mode of action, so far as I understood it, by which the electrical clocks produced their effects, and I was of opinion I could improve them by limiting my invention by the following conditions, which had occurred to me four years before, viz.: 1st, That nothing should interfere in the least with the pendulum, and 2d, That the electrical current should pass through no part of the proper clock. I applied my tilt hammer of 1844, and succeeded quite to my satisfaction. The most agreeable point was, that on trial it appeared that the electric attachment to my astronomical clock did not change in the least its rate of going. This attachment caused the electro-magnet to reciprocate audibly and visibly, and would have caused a proper magnetic clock to be moved secondarily at the greatest distance to which the wires extend. It fulfilled admirably the conditions suggested by Mr. Walker. But this invention, thus cleared of frictional contact and of interference with the pendulum, was still a mere magnetic clock and not a "*chronograph.*" In the course of my experiments it occurred to me that by combining two other instruments with this clock, viz.: the Morse's Register,* or its equivalent, and a break-circuit

* The term "Register" here, and in several other places, is used to mean the clock-like machine which carries forward the fillet of paper, while the magnet in Morse's machine, or the chemical tracers in Bain's, marks traces upon the paper so moved.

key, I could, at any distance, print or write down on the Morse fillet, the time in seconds or other units, represented by lines and short breaks; and *print* into the time-scale the exact moment of an event, by breaking the circuit, and thus causing a blank or break to be commenced in the line being generated. The plan was immediately drawn, the work executed, and the actual experiment made with perfect success. Almost every astronomical observer has intuitively felt a desire to have some kind of a chronograph with which to subdivide a second, and record fractionally the punctum of his observation. The idea has undoubtedly occurred again and again to the observer, that if he could have a disk revolving with *exact uniformity* one inch or so per second, and he could dot down appropriately in that inch his observation, without listening to, or looking at, a clock, it would greatly improve both his work and the means of performing it. Unfortunately, this *perfect uniformity* of motion has never been attained.

11. But in the electro- or electro-magnetic chronograph, although perfect uniformity of motion is by no means attained, yet the error thus arising is diminished to that which is inappreciable. For as the velocity, although variable, is measured every second, the only error necessarily created is that arising from the change of velocity during one second of time, a quantity exceedingly small. And even this small quantity may be quite removed by finding its value from the law or *rate* of change exhibited by several consecutive seconds, as indicated by the length of the lines representing them. The mean length of the lines preceding and succeeding the observation second, will mostly give a denominator so nearly of the true value, that, practically, the result may be considered quite perfect.

12. As the invention was developed and perfected, a copy of my journal of the work was currently transmitted to Prof. A. D. Bache, LL.D., Superintendent of the U. S. Coast Survey, to consult his opinion of its utility.

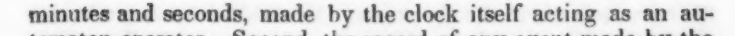
Mr. Bache became so well satisfied of its value that on the 18th of December, 1848, he made the request, by telegraphic despatch, sent by Mr. Walker, that I would grant permission that he might communicate it officially, in the form of a report, to Congress. That permission was granted by me, December 20, 1848, and the report was made. It seems, the sub-report of Assistant S. C. Walker had already been written, as it was dated December 15.

13. *Letter of Prof. Locke, published in the Cincinnati Daily Gazette of Nov.* 30, 1848.

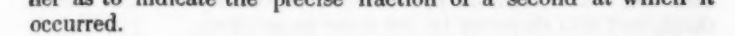
It will be understood by my last paper on the subject of a Clock Register, that two kinds of marking upon the fillet of the telegraph are contemplated. First, the register of time in hours,

minutes and seconds, made by the clock itself acting as an automaton operator. Second, the record of any event made by the hand of the observer, in the midst of the seconds, in such a manner as to indicate the precise fraction of a second at which it occurred.

First, then, the Automatic record of time.—By the Automatic Clock, the fillet will be marked to indicate seconds of time, thus:



In this specimen, *lines* and *breaks* are represented instead of dots and lines as described in my last. The beginning of a minute will be indicated by the omission of a break and the running together of two lines, thus:



The middle of this long line is then the beginning of a minute. The beginning of ten minutes will be shown by the omission of two breaks, and the beginning of every hour by the omission of three breaks when four lines will run together.

Second, of the Manual record of any special event.—The commencement of an eclipse, the noon-point of the sun, or of a star, or any other event desirable to be marked precisely, is registered by the observer by breaking the circuit at any point by hand: this will appear in the fillet thus:

In this example the event is recorded at four seconds and fourteen-hundredths of a second, the point [indicating the event] being the commencement of the break.

The apparent obliteration of the breaks, indicating seconds, by omitting two or three [as in indicating the commencement of every ten minutes and every hour] or a blank for a second or two, creates no difficulty, for they can obviously be restored by a pair of dividers. The complete circuit [for this operation] will then include a battery, register,* and keys as usual (keys for breaking the circuit), and besides these, the Automatic clock. The observer and key must be at the place of [observing] the "event," say at St. Louis, while the other parts may be ever so remote, say at Washington city, or any where along the circuit.

14. *Description of Dr. Locke's "Chronograph," from the pen of Coast Survey Assistant, Sears C. Walker, as re-published in the Cincinnati Daily Gazette.*

The following account of this late invention, from an article furnished by Coast Survey Assistant, Sears C. Walker, to the United States Gazette, is a perfectly graphic and true picture of

* See Note, page 235.

the circumstances of the invention. Mr. Walker, having witnessed the development of the thing here, and leaving on Nov. 19th, travelled direct for Philadelphia, where the article appeared on Dec. 1st. It is from an eye-witness, while it was fresh in his mind, and will therefore be the more satisfactory.

"Dr. John Locke, of Cincinnati, has invented a very cheap and simple instrument, which can be attached to the same pivot along with the second hand of any clock, and which will, when put in connection with the telegraphic circuit, make the clock beat at the same instant all along the line.

"The hours, minutes and seconds, may be registered on the fillet of paper, *and by striking on the telegraphic key at the instant of any occurrence, the date of it is recorded on the same paper to the hundredth of a second.* This invention will be useful for many practical purposes. It makes the current of time visible to the eye in a permanent record. *It does not change the rate of going of the most delicate clock.* It will doubtless be applied hereafter to many purposes for the advancement of science; such as the determination of geographical longitude, in connection with transit instruments, the measurement of the velocity of sound; perhaps, if the circuit be long enough, of the lightning itself.

"The mechanical invention is due to Dr. Locke. It is proper, however, to remark, that the first suggestion of the use of the telegraph line in connection with the determination of longitude, was made by Prof. A. D. Bache, the Superintendent of the United States Coast Survey, in the winter of 1843–4.

"The subject has, under his direction, been making constant progress towards the perfection of the art. Several thousand dollars have been expended in the construction of lenses, instruments, &c., and in practical observations for longitude. The great desideratum in the work was a telegraphic clock, which, without having its performance injured, should register, as Dr. Locke's attachment does, the hours, minutes and seconds at the stations of the coast survey, in connection with the line. The list of requisites* for coast survey operations derived from three years experience, was furnished to Dr. Locke under the direction of the Superintendent, by Sears C. Walker, the assistant in charge of this department, on the 28th of October. The invention of the attachment was completed by Dr. Locke, on the 4th of November. A model was constructed by Dr. Locke's son, a skillful mechanician, and on the 15th was attached to an astronomical clock, made by Dr. L., with his own hands. The coast survey

* This list of requisites did not include any suggestion or hint with regard to the "*printing*" or chronographic mode of observing. It consisted of the suggestions specified on page 235, *in italics*.

made an arrangement with the Telegraph Company in Cincinnati, to extend their circuit through Dr. Locke's house, on the 17th inst., and the first experiment was tried with complete success. Let us give credit to whom credit is due. Without the persevering enterprise of the superintendent of the coast survey, the immediate desideratum might not have been fixed upon. When this was known, however, it was no easy matter to effect it without injuring the performance of the clock.

"The most expert clock makers and mechanicians, and the most expert telegraph operators and inventors, including Dr. Morse himself, had been consulted. None had succeeded in a mode that was absolutely satisfactory. It required the union of all the arts of electro-magnetism, of clock-making, and of telegraph registering in the same person, in order to insure success. Dr. Locke had all the requisites. He made the invention. His son made the model. It was attached to a clock made by himself. It was tried on a register of his own invention and handicraft. He is, therefore, in every sense, the inventor of the attachment. The utility of the invention to the Coast Survey is so great, that one night's work, with the new apparatus and such accompaniment as will necessarily be provided, may perhaps be worth as much in practical results as a whole campaign would be without it.

"Dr. Locke's attachment may be made to register far smaller subdivisions of time than hundredths of a second. Instead of the fillet of paper, we may substitute a metallic cylinder, revolving like a barrel-organ, with the hours, minutes and seconds traced on it in a spiral line with such precision, that a second of time may be subdivided into ten thousand parts, all susceptible of distinct measurement with a microscope. Such a portion of time is supposed to be occupied by lightning in traveling eighteen miles. A hundred of them are taken for lightning to travel from Eastport to New Orleans. One continuous line will next year connect these places. The lightning will then take for its passage a line 100 times as long as the smallest portion capable of being measured by Dr. Locke's attachment. K."*

Dr. Locke's invention consists in part in the evolution of a perfect time-scale, marked not only with seconds or units of time, but with the larger divisions, as minutes, five minutes, and hours; and in *the entering or imprinting of the exact time of events, as astronomical observations, upon the same time-scale* by electromagnetic or other means, as circumstances may require or permit; this being done without injuring the rate of going of the clock.

* The article was written by Mr. Walker, but was carried to the press by his half-brother, Prof. Otis Kendall, of Philadelphia.

By this invention the observer need not have a clock at his station—only one clock is necessary.

15. *Letter of Prof. Locke to Lieutenant Maury, Director of the National Observatory, Washington, D. C., dated Cincinnati, Dec.* 13, 1848.

I enclose to you a specimen of my late invention, the telegraphic-clock for longitude, (now called the electro-chronograph.) The clock breaks and closes the circuit in such a manner that the seconds are registered in lines about half an inch long, with short breaks between them. This is done without any interference with the pendulum. To indicate the minute zero, a break is omitted when two lines run into one, about one inch long.

Every five minutes, a long line (three seconds) *follows* the minute zero. Of course the five minutes terminates at the minute zero. Every hour a similar dash *precedes* the minute zero, each of these dashes is separated from the minute zero by a few distinct seconds. At the commencement of an hour the three signals come together thus:

Hour signal.	Minute zero.	Five Minute signal.	Observation.

Star transits are marked by blanks or breaks made by a finger key under the hand of the observer, (see specimen.) The commencement of the break is the punctum of time of the observation. As this may happen between the little breaks between seconds, and be thus a little (one-tenth second) indefinite, I have invented a key which shall measure the breaks and make either end available. By scale and dividers these breaks can be measured to hundredths of a second. The use of such a clock to determine longitude on a telegraphic line is evident. It occurred to me that it might also be useful in a local observatory as a faithful and convenient register of observations, and especially as it subdivides seconds very accurately. It would relieve the observer from ocular and auricular clock trouble, which when there is a noise about you is often vexatious. The observer has only to watch the transit and press the key at every wire, without ever taking his eye from his telescope. If not used as a substitute for usual clock readings, it might be a convenient check and auxiliary. If it is thought that it will be useful, it has been proposed that two such clocks be made by our government, one for your Observatory and the other for the Coast Survey. The operation of my clock is as perfect as I could wish, so far as I have observed, and the machinery does not appear to interfere with its rate.

Mostly, in the observations, the hour and five minute signals would be of little or no use, and might be thrown out of action.

16. *Lieutenant Maury's Letter announcing officially Dr. Locke's invention to the Hon. John Y. Mason, Secretary of the Navy.* (*From the National Intelligencer of June 8th, 1849, and dated, National Observatory, Washington, January 5, 1849.*)

I have the honor of making known to you a most important discovery for astronomy which has been made by Dr. Locke, of Ohio, and of asking authority from you to avail myself of it for the use and purposes of this Observatory.

The discovery consists in the invention of a magnetic clock, by means of which seconds of time may be divided into hundredths with as much accuracy and precision as the machinist with rule and compass can subdivide an inch of space.

Nor do its powers end here. They are such that the astronomer in New Orleans, St. Louis, Boston, and any other place to which the magnetic telegraph reaches, may make his observations, and, at the same moment, cause this clock, here in Washington, to record the instant with wonderful precision.

Thus the astronomer in Boston observes the transit of a star as it flits through the field of his instrument, and crosses the meridian of that place. Instead of looking at a clock before him, and noting the time in the usual way, he touches a key, and the clock here subdivides his seconds to the minutest fraction, and records the time with unerring accuracy.

The astronomer in Washington waits for the same star to cross his meridian, and, as it does, Dr. Locke's magnetic clock is again touched;* it divides the seconds and records the time for him with equal precision. The difference between these two times is the longitude of Boston from the meridian of Washington.

The astronomer in New Orleans and St. Louis and every other place within the reach of the magnetic wires, may wait for the same star, and as it comes to their meridian, they have but to touch the key, and straightway this central magnetic clock tells their longitude.

And thus this problem, which has vexed astronomers and navigators, and perplexed the world for ages, is reduced at once, by American ingenuity, to a form and method the most simple and accurate. While the process is so much simplified, the results are greatly refined. In one night the longitude may now be determined with far more accuracy by means of a magnetic telegraph and clock, than it can by years of observation according to any other method that has ever been tried.

* The clock itself need not be touched, for it may be a thousand miles away from the observer. The break-circuit key must be touched, as in Lt. Maury's next paragraph.

It is, therefore, well entitled to be called a most important discovery. It is a national triumph, and it belongs to that class of achievements by which the most beautiful and enduring monuments are erected to national honor and greatness; and my feelings of professional pride will not allow me to pass it by, without calling your attention to the garland that has been hung about it by the navy.

To the navy belongs the honor of having first applied the magnetic telegraph to the determination of longitude. Five or six years ago Capt. Wilkes, of the navy, used it for determining the difference of longitude between this city and Baltimore. This was the first time it had been applied to such a purpose, and it was a great improvement upon the methods which up to that time had been used for finding the longitude, for it reduced the results down to the accuracy with which the time between the ticks of the second-hand could be measured on the face of the clock by the eye and the ear. And thus the honor of being the first to convert the magnetic telegraph into an astronomical instrument, and that too into one of great practical value and importance, was secured by one of its officers to the American navy. Though the errors of the problem were greatly reduced by this discovery, there were, however, small sources of error still remaining, and it remained for Dr. Locke, formerly an officer of the navy also, to devise a means of eliminating them so completed that now there is scarce a trace left in the results, so free are they from doubt and uncertainty. The probable error of longitude determined with Dr. Locke's clock is brought within such narrow limits that if, while the astronomer in St. Louis or elsewhere were operating upon the magnetic clock here for his longitude, the observer in Washington were to move from one instrument to another in this building, the fact that he had moved would be made known at once, and whether he had moved to the east or the west would be told by the clock, and appear in the resulting longitude.

Dr. Locke was formerly a member of the medical corps of the navy, and as such, spent a portion of his manhood and prime years of his life at sea.

It is therefore, not surprising that sailors should be quick to lay hold of the problem of longitude through any improved means that may be offered for its solution. Every one can see the importance of accurate determination of longitude, but sailors both see and *feel* it. In his letter to me, describing his clock and giving an account of its performance, Dr. Locke kindly offers to put one in this Observatory.

It would be of incalculable service and advantage. It would increase the accuracy of results, and greatly multiply them in numbers. With this clock one observer could do more and better work than two can now. An illustration of the value of such a

clock just now occurs. I am writing at night, the sky is very clear, and it is the first fair night for observations that we have had this year. The wind is very high, and the observers have just come in to say they cannot hear the clock, on that account, and therefore they cannot observe. Now it is not necessary to hear, or even to see the magnetic clock, and had we one, we could work quite as well in windy as in calm weather. While, therefore, one of Dr. Locke's magnetic clocks would be of such value to the Observatory, it would, without at all interfering with that value, be of incalculable advantage to the public generally; for wherever in any part of the country there is a transit instrument and a line of wires, this clock may be used by the observer at that instrument, not only for recording his observations, but also for determining his longitude from the capitol of the country; and thus it would without cost or trouble, enable the National Observatory to perform a most important part of appropriate duties, and a most acceptable service to the world in perfecting the geography of the country, and in affording so many well-determined points of departure for the traveller, the surveyor and the navigator.

17. *The reply of Lieutenant Maury, Director of the National Observatory, at Washington, to Senator Corwin, of Ohio, (dated National Observatory, Washington, D. C., February* 17, 1849.)

I am this morning in receipt of yours of the 16th inst., in which you request my opinion as to "Dr. Locke's claim, and the utility of his clock."

I consider Dr. Locke's invention as one of the greatest improvements of the age, in practical astronomy. Other persons have invented "Magnetic Clocks," but all those clocks, as far as I know, beat seconds and leave the astronomer precisely where he was before, as it regards the subdivisions of seconds.

He had by them, as with other clocks, to trust to the eye and the ear for the division of seconds. It was a great desideratum with astronomers, and an important matter for the world, to obtain the means of subdividing the seconds of time with accuracy and certainty, for a second of time, in the determination of longitude, is equal to a quarter of a mile.

Dr. Locke took up this subject where others had left it, and by means of an attachment to a common clock, by the aid of electro-magnetism and a common registering apparatus used in telegraphic offices, devised the means of subdividing accurately and with precision, seconds of time into hundredths, or even into thousandths, if need be.

He has chosen to call his invention a "Magnetic Clock." I think that is rather a misnomer; for a clock to be driven by mag-

netism, instead of by weights, has been invented in England. This is truly a magnetic clock, and Dr. Locke's attachment or contrivance for subdividing seconds may be connected with the magnetic clock as readily as with any other. At any rate, without going into the fitness of terms, the expression "Magnetic Clock," is not descriptive of Dr. Locke's invention.* But as a practical illustration of the value of Dr. Locke's invention, I may mention the fact, that we have for four years been making observations here continually for the purpose of determining the longitude of this place. After we shall have been at work for twice that time—I might say for a life-time—if we succeed in determining the longitude of the Observatory within the limits of the lot in which the building stands, seventeen acres, we should consider ourselves as well repaid for the labor and time employed.

Now with Dr. Locke's invention, the difference of longitude between this Observatory and any other point, reached by magnetic telegraph, may be determined in one night so closely as to show in what part of the building the observations were made.

And thus, by having one of Dr. Locke's clocks here, this Observatory may be connected with every other observatory in the country in such a manner as to make all their observations for *their* longitude from Greenwich to other European observatories, available for determining *our* longitude also from the same places.

It will enable the Observatory in a single night to determine the difference of longitude between the capitol to any other place, reached by magnetic telegraph, with far more accuracy than it can be done without it, and thus enable this Observatory to fulfill, in the most satisfactory manner, one of the most important objects of a National Observatory, viz: that of perfecting the geography of the country and of affording in different parts of it well and accurately determined points of departure for the traveller, the surveyor and the navigator.

It will enable the observers now employed here to do double, perhaps treble, the quantity of work that they now do, and to do it better.

The instruments require five clocks;—with Dr. Locke's improvement applied to one of them, all the others may be dispensed with.

I might go on in the enumeration of the advantages to the public service, the facilities and the powers which this invention give the astronomer, were I at liberty to explain the principles and give descriptions of the invention in its present state; suffice it to say, that ingenuity has been successfully exercised to such an extent in the matter, that, though there be six astronomical instruments here, one of these clocks will record the observations

* Dr. Locke's invention is now called the "Electro-Chronograph."

of all at the same time, and the record will not only show separately the work of each instrument, but if the observations be interrupted by clouds or any other cause, as they frequently are, it will show upon what wire in the telescope the star or other object was at the time when the observation was made.* In view, therefore, of the importance and practical value of this invention, I consider that Dr. Locke has been as modest in his claims as he is with regard to his own merits.

18. *The fifteen properties of the Chronograph contrasted with the three positive properties of the common magnetic clock, as communicated to the Secretary of the Smithsonian Institution, March*, 1849, (*in a letter to Prof. Henry, from the author, dated Washington, March* 1, 1849.)

I am anxious to have your opinion on the subject of my invention, and I therefore put down some of its qualities as contrasted with those of other clocks:

ORDINARY MAGNETIC CLOCKS

1. Operate by interruptors or electrotomes.
2. Cause electro-magnets to reciprocate at a distance.
3. Impel other simpler clocks.
4. Negatively, when the secondary clocks become retarded or advanced by atmospheric electricity or otherwise, they will remain constantly in error until corrected by some external means.
5. Negatively, their mechanism is such as renders it impossible to use them for recording observations. See Art. 4 and 5.

DR. LOCKE'S ELECTRO-CHRONOGRAPH

1. Operates by interruptors or electrotomes.
2. Causes electro-magnets to reciprocate at a distance.
3. Impels other simpler clocks.
4. Positively, when the electricity interferes with the current in the wires, the time-scale, issued from the Morse Register, and marked by my clock, though its evolutions may be temporarily interfered with, yet as soon as the interfering cause is removed, will issue in exact correspondence with the clock.

The Morse Register may even be stopped and the graduating of the scale be thus interrupted, yet when it is started again, it will not recommence where it left off, but will indicate the then time of the clock.

5. The dial and hands remain on, and the clock can be used for ordinary purposes by eye and ear.

* The part of the invention to which Lieut. Maury alludes in this paragraph, was confidentially committed to him, and has never been made in any degree public. In this item the officers of the National Observatory itself are entitled to a share of credit which will ultimately be distinctly accredited to the proper authority.

6. By being connected with the ordinary telegraphic circuit it will cause a time scale to be issued at any telegraphic distance, said scale being marked by lines or dots* representing seconds or other primary divisions of time.

7. It will mark on the time scale the beginning of every minute.

8. It will mark the beginning of every 5, 10, 20, &c., minutes.

9. It will mark on the time scale the beginning of every hour.

10. It enables the operator at any part of the telegraphic wires to print down either there or at any other place in the circuit, *the occurrence of any event to the hundredth, or, if need be, to the thousandth of a second*, a property which the magnetic clocks would not possess even if they were connected with the registering machines. See Art. 4 and 5.

11. By the 10th property, *it enables the astronomer, from any point of the circuit, by a touch of his finger, to print on the time scale at any other points of the circuit, a legible and permanent record of his observations*, accurately as described in 10.

12. It enables one clock to operate through any extent of complicated circuits, to generate time scales from all registers included in them, and permits separate and independent observations to be made and printed into each and every of these time scales, without any interference with each other, and all this too, with but a single circuit, and a single battery in that circuit.

13. Thus, at two points selected for determination of difference of longitude, *one clock* only is required, and the use of that clock is better than two or more, because of the absolute unity or synchronism which is thus attained.

14. For an observatory with several instruments, or for any number of observatories situated distantly from each other, but *one clock* is needed, and for reasons named in 13, that one clock is better than many.

15. All this is done without changing the rate of going of the clock, and all the above properties have been tested by actual trial.

19. By far the most formal document which has appeared in reference to the electro-chronograph, has been the report of Dr. Bache to Congress, including the sub-report of Coast Survey Assistant, Sears C. Walker, which last has been published in your Journal.

20. My remarks upon that report will be confined chiefly to such points as are known to have produced misapprehension. An officer of government informed me, that as he understood the report of Mr. Walker, the intention, of some parts of it at least, was to attribute the invention of the chronograph not to myself, but to another person.

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* One or the other by adjustment.

21. It seems that his report has been rendered obscure and ambiguous, by the introduction of a new coined word, borrowed in part at least from an expression in my letter to the Gazette, where I name my invention the "Automatic Clock." But Mr. Walker has used the term "automatic clock register," not exactly in the sense in which I used the first part of the phrase, nor has he used it in a uniform sense as is evident from his context. It was well perhaps, as a matter of taste, to avoid the too frequent introduction of my own name, but when my invention is so often called the "Automatic clock Register" some more intelligible phrase would certainly have been preferable. I have not a copy of your Journal before me, and I therefore quote from the original document as published by Congress.

22. The following is Mr. Walker's introduction, p. 2, Doc. 21.

Washington, D. C., December 15, 1848.

"*Dear Sir:* I beg to call your attention to the importance of the use of an electro-magnetic circuit and an astronomical clock in connexion with Morse's telegraph register for the operations of the coast survey, and the general purposes of practical astronomy. Your thoughts having been first turned to the subject of the use of Morse's electro-magnetic telegraph in the longitude operations of the coast survey, in December, 1844, special instructions were issued to me in the autumn of 1845. Under these and subsequent instructions, the operations of 1846, '47 and '48, entrusted to my care, have, until near the close of the latter year, been conducted without the use of the *automatic clock register.*

"The importance of the latter instrument induced you to direct the necessary researches to be instituted, for the purpose of introducing it into use in the coast survey service. Several methods have been suggested by eminent mechanicians and electro-magnetists. That of Mr. Wheatstone is briefly alluded to in the proceedings of the Royal Astronomical Society, for 1841, November 19th. The galvanic circuit in his clock, is made and broken by the use of a circular metallic disk, put on to the arbor of the seconds' hand. Alternate intervals of a second, or one-sixtieth of the circumference, are made of a non-conducting substance. The disk is insulated and connected with one pole of a galvanic battery. A delicate spring connected with the other pole presses gently on this disk. Thus the circuit is made and broken at alternate seconds. This mode enables the primitive clock to control the motion of any number of clocks in connexion with it. Every time the circuit is broken or made, any receiving clock-wheel with sixty teeth may be made to advance one second, and this wheel may in the usual way control the minute and hour wheel."

As Mr. Walker uses the term "Automatic clock Register" in the following part of his report to signify the "Printing Method"

of observing, or in other words my own invention, acknowledged to be so by him, it would seem by the above phrase, that Dr. Bache was apprised of its existence before it was invented, and that he directed "the necessary researches to be instituted for the purpose of introducing *it* into use in the coast survey service." But when Mr. Walker proceeds to say, "That of Mr. Wheatstone," &c., and again that "this mode enables the primitive clock to control any number of clocks in connexion with it," it appears that he uses "Automatic clock Register" to signify merely the common magnetic clock of Europe, or the mere clock interruptor, and with this interpretation the absurdity alluded to vanishes.

23. In the next paragraph, Mr. Walker relieves the reader entirely of all ambiguity by saying, "I find, as yet, no account of the application of these electro-magnetic circuits, and astronomical clocks to the purpose of permanently registering the current of time on the running fillet of paper, as used in Morse's Electro-magnetic Telegraph," p. 3. He goes on to state, that "It is, however, this latter combination which we must employ in our telegraphic operations for longitude."

24. Mr. Walker next describes the various kinds of break-circuits, or clock interruptors, including my own, with reference to the connexion with the registering machine according to my "printing method," and adds:

"I think it is manifest that either method will succeed in practice, which alone can test their relative excellence. To Mr. Wheatstone, however, belongs the merit of priority in effecting the primary object of causing the astronomical clock to make and break the circuit of a galvanic battery, without injury to the machinery or movement of the clock."

I have shown, that none of these interruptors will perform in connexion with the registering apparatus unless they be essentially modified. If Mr. Wheatstone's contact wheel were made with slight breeches only, thus permitting the circuit to remain closed nearly all of the time, and rendering it possible to mark the observation, it would answer the purpose well. But this would be an essential modification, and would make it the equivalent of my own invention for the same purpose. Here Mr. Walker ought to have given me credit not only for *combining* the clock and the registering apparatus for the purpose of printing *time* and *observations* at a distance, but also for the invention of such a clock interruption of electricity as rendered the imprinting of observations *possible*. But I have already shown that this has been, in some way, naturally an obscure point, having been overlooked by others besides Mr. Walker. It is undoubtedly the misty point which had so far prevented the invention from having been made at an earlier period.

25. The experiment of Prof. Mitchel mentioned, p. 4, furnished a dotted fillet, on which not only were no observations printed, but for reasons which I have previously shown, none could be so printed, under the usual conditions of telegraphic distance, a single circuit and a single battery.

26. "On the 17th of November last, Dr. Locke's delicate astronomical clock, of his own construction, was supplied with the requisite apparatus made from his drawings by his son. At the expense of the coast survey, I directed wires to be put up for the purpose of connecting his clock with the Cincinnati and Pittsburg line, about four hundred miles in length. The experiment was eminently successful, and the registering of the seconds of time on the running fillet of paper was continued for two hours at all the offices along the line, much to the astonishment of the operators. I send you a specimen of the graduated fillet of paper. It consists, as you will notice, of an indented line of about nine-tenths of an inch in length, followed by a complementary blank space of about one-tenth. The two make a second of time, commencing with the beginning of the line."

The above paragraph, p. 4, is a clear announcement of facts.

Here Mr. Walker defines the term "Automatic clock Register," but he does not say whether "graduated fillet" means a fillet graduated both with time marks and observations, or merely the former. He uses the term subsequently, however, including both. and in that sense it is equivalent to my electro-chronograph or the Printing Method of *observation*. Prof. Wheatstone's interruptor could not furnish it.

27. "In order to carry out fully your wishes and instructions, it would be necessary that this automatic clock register should distinguish the hours, minutes and seconds. Dr. Locke proposes for this purpose to make the beginning of the ordinary minutes omit *one*, of *fives* of minutes *two*, of *tens* of minutes *three*, and of *an hour* omit *four* consecutive blank spaces. Thus *ordinary* beginnings of minutes have continuous lines of *two* seconds, *fives three*, *tens four*, and *hours five*."

The above paragraph is somewhat ambiguous and conveys the idea that the author's patron had anticipated the invention and gave "instructions" that the "automatic clock register" should "distinguish the hours, minutes, and seconds." One would suppose that this was one of the items in the "list of desiderata furnished to me."

I have given the only suggestions which were made to me, and had I done no more than accomplish the objects there proposed, I should never have claimed to myself the performing of any thing worth the effort of recovering. It is true that Mr. Walker called my attention, at that time, to the subject; and in aiding him to do what he suggested, I pursued the subject

still further, and invented the electro-chronograph which superseded entirely, the plans primarily suggested to me. This invention was exclusively my own, and when it was communicated to Mr. Walker and to Dr. Bache, they both expressed their agreeable surprise; nor was it without some great effort that I made my plans intelligibly understood. It could not for example at first be seen that only one clock was necessary in the operation. Nor has the very basis of the whole affair, the *closed circuit*, been practically understood up to this moment. Mr. Walker never intended such a meaning as has been attached to the passage, for that meaning is inconsistent with truth, and with his previous statements.

28. "The mode of using the register for marking the date of any event that cannot be determined *automatically*, but whose occurrence must be known from human sensations, is to tap on a *break circuit key* simultaneously with the event. The beginning of the short blank space thus registered in the midst of the indented line of the *automatic clock register*, fixes, by a permanent printed record, the date of the event, or rather the date of the human estimate of the event, as indicated by the tap of the key.

"For this mode of distinguishing the hours, minutes and seconds on the fillet of paper, and for the idea of using the break circuit key, I was indebted to Doctor Locke. This kind of key is required by the necessity of having a closed circuit for the *register* as much of the time as possible, so that an event occurring any where along the line may be instantly recorded on the register."

In the second paragraph, "For this mode," &c., instead of being credited with the whole combination of the "Printing Method" both generally and in detail—I am represented as furnishing piece work for a master. Mr. Walker acknowledged himself indebted to me for a "break circuit key"! and a mere "tilt hammer" interruptor I suppose. So inconsistent are these expressions with the frank communication of the same author to the U. S. Gazette, already cited, that I will not attribute them to him, but to some Mentor especially solicitous that Dr. Locke and his invention should not be "praised too much."

The author closes his paragraph by a very proper allusion to the necessity of a "closed circuit" as pointed out in my letter to Dr. Bache, but he has every where practically disregarded that principle by citing machines which do not fulfill that condition, as the equivalents of my own.

29. "The great importance of an automatic telegraph clock has often been the subject of conversation between us, but your chief efforts were, necessarily, directed at first to the means of procuring it. A hasty glance at the advantages that would result from the certain possession of such an instrument, was made by

Dr. Locke and myself on the evening of the 17th of November, while watching its performance for a term of two hours or more. Having reflected much since, and consulted with my friends both in and out of the coast survey, I am more and more convinced that it is difficult to form an over estimate of its importance in every department of practical astronomy that involves the nice determination of absolute dates, or of their relative intervals in time."

In this paragraph, if we understand "automatic telegraph clock" to mean the chronograph or the "Automatic clock Register," printing time and observations, Mr. Walker represents himself and his patron in such a relation, that the readers of the article understand him to say, that it was understood by them before it was invented by me. I have no doubt the gentlemen had conversed about a common magnetic clock which should produce visible and audible action at telegraph distances, and this is the only interpretation consistent with the other productions of Mr. Walker on the same subject.

30. On p. 10, the author writes as follows:

"I would, for this purpose, respectfully recommend the mounting of one of Mr. Wheatstone's, or of Dr. Locke's clocks at some central astronomical station," &c.

Here as elsewhere, the equivalency, which I have shown has no existence, has been assumed to be true, and the credit of the combination invented by me is also disregarded. Superadding the printing or registering machinery to Mr. Wheatstone's clock, would be using my invention. Even then no observations could be registered without first modifying even the electrical machinery of that clock to accommodate it to the principle of the "closed circuit."

31. I am certainly indebted to Mr. Walker and to Dr. Bache for acknowledgments of my claim in no way ambiguous or obscure. The following as it appeared in the National Intelligencer, as the abstract of Mr. Walker's report, is precisely to the point.

"Electro-magnetic clocks were invented in England by Mr. Wheatstone, about the year 1841. They are described by Mr. Steinheil, in Munich, in 1844. They were used to make several clocks on the same telegraph line mark the same instant of time. The coast survey service has substituted Dr. Locke's recent invention, differing from any heretofore described, and having the advantage of furnishing the permanent record instead of the fugitive indication of the course of time."

Dr. Bache also, in his introduction to Mr. Walker's sub-report, p. 2, observes:

"I have received from Dr. Locke, of Cincinnati, specimens of recording by his electro-magnetic clock, which entirely fulfill all the conditions required by the astronomer."

32. To Dr. Bache and his officers of the coast survey, belongs the credit of systematic and persevering efforts to determine longitude telegraphically; and incidentally their efforts to improve the means of such determination have been the cause of my making the invention under consideration. Mr. Walker is enthusiastic; his manner and conversation are exciting, and he was very prompt to perceive, appreciate, and make known, the advantages of the *printing method of observing*. His invention of a telescope with cross hairs multiplied in proportion to the rapidity with which observations can be made by my chronograph, is evidently a valuable one. Indeed in that which is the special department of Mr. Walker, the astronomical part of the report, it is unnecessary for me to say that he has done himself his usual credit. The ambiguities which I have been obliged to notice, have been the result of rather a hasty use of a new term, a want of a clear perception of the necessity of a closed circuit, and a consequent confounding of my invention with the ordinary magnetic clocks, neither intended for *printing of observations*, nor possible to be used as a *part* even of the mechanism for that purpose.

33. At certain points I have indeed had good cause to feel indignant at the course pursued towards me. Men professing to be astronomers, have not only asserted their determination to use my invention, not only without my permission, but without giving me the least credit; but they have endeavored by all means in their power to belittle my claims, and to defeat my political friends in procuring that reward from government which in their opinion was merited.

In the last point it appears they have been unsuccessful. However grateful it may have been to me that my friends in Congress have made themselves fully and particularly acquainted with the subject of my labors, and have procured from such high authority, a decision in my favor, still I have deemed it incumbent on me thus to place in a clear light those points, concerning which I had been informed there had been some misapprehension.

ART. XIX.—*On the Curve described by a Movable Pulley;* by A. SECCHI, Prof. of Nat. Philos. and Mathematics in Georgetown College, D. C.

IT frequently happens, that many obvious facts remain unconsidered during a long space of time, until attention is drawn to them by mere chance, and I doubt whether this may not be the case with the problem which I now lay before the public. It is a fact, (which has been no doubt often observed,) that the movable pulley when raised, describes a curve; but I am quite

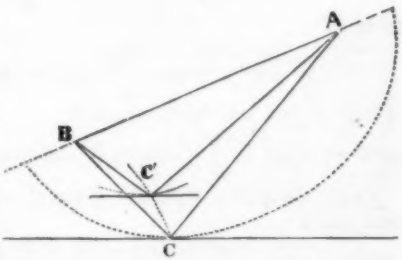
uncertain whether any one has determined what kind of a curve is formed. This I discovered almost three years ago, and the result then seemed so simple and evident that I could scarcely believe that no one had ascertained it before: and for this reason I delayed its publication. If the subject has ever been touched by any one, it has never I think been considered on so large a scale as this. In the process of the solution it will be seen that besides the advantage of a mechanical invention, we have in it a hitherto unknown affinity between the ellipse and hyperbola and a new kind of a general mathematical problem.

Problem.—To find the curve described by a movable pulley, when the fixed point and fixed pulley are *not* in the same horizontal line.

Suppose for the sake of simplicity, that both pulleys have an infinitely small radius; so that they may be regarded as points, or what is the same that the pulleys are rings, through which the cord passes without friction.

Let A be the fixed pulley, B the fixed point and C the movable pulley. BCA is the cord that suspends the pulley. It is well known by the principles of mechanics—that a pulley or ring, thus suspended, will be in equilibrio, when the direction of gravity is *normal* to the curve it would describe if moved freely along the cord, and always in the same vertical plane. But this curve is an ellipse whose foci are A and B, and whose transverse axis $=AC+CB$; and the line of gravity being vertical, and the lowest point of the ellipse being the only one at which the tangent is horizontal, it follows that the pulley will be in equilibrio only at the lowest point C of the ellipse.

1.



When the cord is pulled, the movable pulley passes successively through other positions of equilibrium which are at the lowest points of ellipses whose foci are A and B, and whose transverse axes are the lengths of the thread from A (through the successive positions of C) to B. These successive positions will therefore be determined precisely as C is determined, and will be on the perimeter of an ellipse of a variable transverse axis and at its point of contact with the horizontal tangent.

By means of these considerations, the proposed problem is reduced to

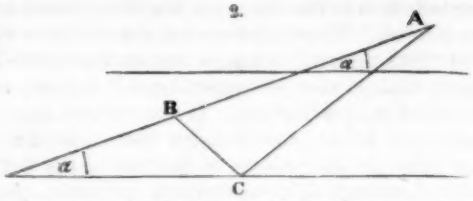
Finding the locus of all the points of contact between an ellipse and a straight line, the transverse axis of the ellipse being variable; whilst its inclination to the straight line is constant: the distance between the foci being also constant.

To resolve this problem, let us assume the equation of the ellipse

$a^2y^2+b^2x^2=a^2b^2$

or $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1.$ (1)

2.



Calling the distance between the foci $2c$, we have $b^2=a^2-c^2$; —calling the angle of the tangent with the axis α and differentiating (1) we have

$$\tan\alpha=\frac{dy}{dx}=-\frac{b^2x}{a^2y}=-\frac{(a^2-c^2)x}{a^2y}=m \quad . \quad . \quad . \quad (2)$$

which being constant we place equal to m.

We may now combine (1) and (2) eliminating a

From equation (1) we get—

$$y^2=\frac{b^2}{a^2}(a^2-x^2)=\frac{(a^2-c^2)}{a^2}(a^2-x^2)$$

from (2):

$$\frac{a^2-c^2}{a^2}=-\frac{my}{x}, \text{ and } a^2=\frac{c^2x}{my+x}.$$

These in the last equation give

$y^2-x^2+yx\left(\frac{1-m^2}{m}\right)+c^2=0$, which is the equation required—(3).

Comparing this with the general equation of lines of the second order

$$Ay^2+Bxy+Cx^2+Dy+Ex+F=0$$

we find $B^2-4AC=\left(\frac{1-m^2}{m}\right)^2+4>0.$

Hence the curve described by the pulley is a hyperbola whose centre is the centre of the ellipse, and whose axis is inclined to the axis of the ellipse.

To determine this inclination and thereby the position of the hyperbola, let ω represent this angle. Then the equations of transformation from one set of rectangular axes to another, the origin being the same, are

$$x=x'\cos\omega+y'\sin\omega\ldots\ldots \text{ and } y=y'\cos\omega-x'\sin\omega\ldots\ldots$$

These values of x and y substituted in (3) which may be transformed into

$$y^2-x^2+\frac{2}{\tan 2\alpha}xy+c^2=0 \quad \left(\text{because } \frac{1-m^2}{m}=\frac{1+\tan^2\alpha}{\tan\alpha}=\frac{2}{\tan 2\alpha}\right)$$

will give

$$\left.\begin{aligned} &y'^2\left(\cos^2\omega-\sin^2\omega+\frac{2\cos\omega\sin\omega}{\tan 2\alpha}\right)+x'^2\left(\sin^2\omega-\cos^2\omega-\frac{2\cos\omega\sin\omega}{\tan 2\alpha}\right)\\ &+2x'y'\left(\frac{\cos^2\omega}{\tan 2\alpha}-\frac{\sin^2\omega}{\tan 2\alpha}-2\cos\omega\sin\omega\right)+c^2=0\ldots\ldots\end{aligned}\right\}(4)$$

which will be the equation of the hyperbola referred to its centre and axes, if $\frac{\cos^2\omega}{\tan 2\alpha} - \frac{\sin^2\omega}{\tan 2\alpha} - \sin\omega\cos\omega = 0.$

or (clearing fractions and dividing by $\cos^2\omega$) if

$\tan^2\omega + 2\tan 2\alpha, \tan\omega - 1 = 0$, whence

$\tan\omega = -\tan 2\alpha \pm \sqrt{1+\tan^2 2\alpha} = -\tan 2\alpha \pm \sec 2\alpha$, or

$$\tan\omega = \frac{\pm 1 - \sin 2\alpha}{\cos 2\alpha}$$

but $-\frac{*1+\sin 2\alpha}{\dagger\cos 2\alpha} = -\frac{2\cos^2(45^\circ-\alpha)}{2\cos(45^\circ+\alpha)\cos(45^\circ-\alpha)} = -\frac{\cos(45^\circ-\alpha)}{\cos(45^\circ+\alpha)}$

$= -\frac{\sin(90^\circ-[45^\circ-\alpha])}{\cos(45^\circ+\alpha)} = -\frac{\sin(45^\circ+\alpha)}{\cos(45^\circ+\alpha)} = -\tan(45^\circ+\alpha)$

in a similar manner we find the first value of $\tan\omega$

$$\tan\omega = +\frac{1-\sin 2\alpha}{\cos 2\alpha} = +\tan(45^\circ-\alpha).$$ Hence

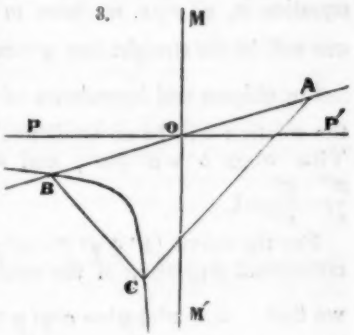
$\tan\omega = \pm\tan(45^\circ \mp \alpha)$. Therefore

$\omega = 45^\circ - \alpha$.....or $= 180^\circ - (45^\circ+\alpha)$.

The difference between these two values is 90°. Therefore if the first value is the inclination of the transverse, the second is that of the conjugate axis.

Since α is the angle made by the axis of the ellipse with the horizon, and ω that made by the axis of the hyperbola with that of the ellipse, $(\omega+\alpha)$ is the inclination of the axis of the hyperbola to the horizon. But $\omega+\alpha=(45^\circ-\alpha)+\alpha=45^\circ$: therefore its axis makes an angle of 45° with the horizon, and is entirely independent of the inclination of the line of the foci to it—which is remarkable.

3.



It may also be shown that this hyperbola is equilateral, and consequently the vertical line MOM′ and the horizontal POP′ are its asymptotes; because, observing that $\sin^2\omega - \cos^2\omega = \cos 2\omega$; $2\sin\omega\cos\omega = \sin 2\omega$, and substituting for ω its value $(45^\circ-\alpha)$, the coëfficient of x'^2 will be reduced to $-\cos 2\omega - \frac{\sin 2\omega}{\tan 2\alpha} = -\sin 2\alpha$

$-\frac{\cos 2\alpha}{\tan 2\alpha} = -\frac{\sin^2 2\alpha + \cos^2 2\alpha}{\sin 2\alpha} =$

$-\frac{1}{\sin 2\alpha}$, and that of y'^2, to ..... $+\frac{1}{\sin 2\alpha}$.

* $\sin(45^\circ+\alpha) = \sqrt{\frac{1}{2}}(\cos\alpha+\sin\alpha)$; squaring, $2\sin^2(45^\circ+\alpha) = \cos^2\alpha+\sin^2\alpha+2\sin\alpha\cos\alpha = 1+\sin 2\alpha$. Hence $1+\sin 2\alpha = 2\sin^2(45^\circ+\alpha) = 2\cos^2(45^\circ-\alpha)$.

† $2\cos(45^\circ+\alpha)\cos(45^\circ-\alpha) = 2(\sin^2 45^\circ\sin^2\alpha - \cos^2 45^\circ\cos^2\alpha) = 2\cos^2 45^\circ(\sin^2\alpha - \cos^2\alpha) = 2(\sqrt{\frac{1}{2}})^2\cos 2\alpha = \cos 2\alpha$. Hence $\cos 2\alpha = 2\cos(45^\circ+\alpha)\cos(45^\circ-\alpha)$.

Equation (4) then becomes $\frac{y'^2}{c^2 \sin 2\alpha}+\frac{x'^2}{c^2 \sin 2\alpha}=1$ (5)

$\alpha=45°$, gives the greatest axes of the hyperbola.

The principles of this solution may be applied to several other problems of the same kind. If it were proposed, for example, to find the locus of all the points of contact of a straight line with a hyperbola whose foci are fixed, and whose transverse axis varies continually, whilst the tangent to the successive hyperbolas makes a constant angle with the axis.

In the same manner as in the preceding problem, we have: $\frac{y^2}{a^2}-\frac{x^2}{b^2}=1$ .... $b^2=c^2-a^2$ .... $m=\frac{x(c^2-a^2)}{ya^2}$ .... whence we obtain the same equation (4) and consequently the same curve.

To account for this identity of solution we must remark, that the movable pulley C may be regarded as a point of the hyperbola whose foci are A and B; and the direction of gravity, always bisecting the angle ACB of the lines drawn to the foci, is tangent to the curve at C.

Now this line makes a constant angle with the line of the foci; therefore the curve described by the movable pulley may be determined by finding the locus of the points of contact of a variable hyperbola with a right line making a constant angle with the axis.

This result shows a new relation between these two conic sections which are already well known as kindred.

A new field is now open for many problems of the same description, but perhaps of no very useful application.

As for parabolas whose parameter varies continually and whose equation is, $y^n=px$, we have $m=\frac{dy}{dx}=\frac{p}{ny^{n-1}}$, the resulting locus will be the straight line $y=mnx$.

For ellipses and hyperbolas of higher orders $\frac{y^n}{a^n}\pm\frac{x^n}{b^n}=1$ the solution will be an equilateral hyperbola of the same species. This when $b^n=a^n\mp c^n$; and $\alpha=45°$ (which makes $m=1$) is $\frac{x^n}{c^n}-\frac{y^n}{c^n}=1$.

For the curve $(x^2+y^2)^2=a^2y^2+b^2y^2$, (which is that of the orthogonal projection of the centre of the ellipse on the tangent) we find $x^2+y^2=c^2y\left(y+\frac{m}{x+my}\right)$ supposing between a, b, and c, the same relation as in the ellipse.

For the circle, m being independent of r, the problem is indeterminate: but it will be easily understood—that the locus is a right line coinciding with the radius continually diminishing.

The practical application of this problem may sometimes be interesting: because by settling conveniently the fixed point and

the fixed pulley, a body can be raised and transported to a new position, without the use of complicated machinery.

For this purpose let the body rest at C, and suppose we wish to transport it to *m*. Regarding the pulley and body as points, the question is reduced to finding an equilateral hyperbola passing through the points C, *m*, and B. The angle α, *c*, and the position of the centre must be determined with regard to the point C.

Let *u* and *v* be the coördinates of the point C: and through this point take two rectangular axes *cx'*, *cy'*, one parallel to the horizon and the other perpendicular to it; *u* and *v* will also be the coördinates of the centre O of the hyperbola relatively to point C. Since the axis of the equilateral hyperbola (see (5)) makes an angle of 45° with the horizon, the equations of transformation to the point C will be

$$x=u-(x_1+y_1)\sqrt{\tfrac{1}{2}}\ldots.$$
$$y=v-(y_1-x_1)\sqrt{\tfrac{1}{2}}$$

by means of which, (5) becomes

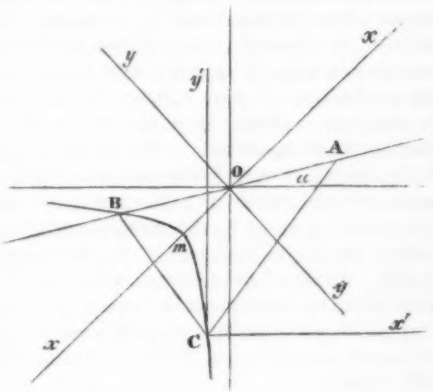
$$u^2-v^2-\sqrt{2}(u+v)x_1$$
$$-\sqrt{2}(u-v)y_1+2x_1y_1$$
$$=c^2\sin 2\alpha.$$

For the point C $x_1=0$ and $y_1=0$, which reduce this to $u^2-v^2=c^2\sin 2\alpha$. (6)

whilst,

$$2x_1y_1-\sqrt{2}(u+v)x_1$$
$$-\sqrt{2}(u-v)y_1=0.$$

4.



If *m* and *n* denote the coördinates of the point *m* we shall have for this point

$$mn\sqrt{2}-(u+v)m-(u-v)n=0.$$

We may also take as known the position of the point B of the curve, and denoting its coördinates by *p* and *q* we have

$$pq\sqrt{2}-(u+v)p-(u-v)q=0,$$

whence $u=\dfrac{mn(p-q)-pq(m-n)}{\sqrt{2}(np-qm)}$ ..... $v=\dfrac{mn(p+q)-pq(m+n)}{\sqrt{2}(mq-np)}$

from these equations we know the value of $c^2\sin 2\alpha$: but *c* and α remain yet undetermined to the great advantage of practice; because we can choose the inclination or the length of the line AB, according to convenience, provided they satisfy equation (6).

Substituting in (6) the values of *u* and *v* just found, the condition is reduced to

$$c^2\sin 2\alpha=2\,mnpq\frac{(n-q)(p-m)}{(qm-mp)^2}$$

the second member of which is entirely known; and any value assumed for *c* or α, will give the corresponding value of the other.

ART. XX.—*Thoughts on Ancient Metallurgy and Mining in Brigantia and other parts of Britain, suggested by a page of Pliny's Natural History*; by JOHN PHILLIPS, Esq., F.R.S., F.G.S.

(Continued from p. 102.)

DID the Cornish or Gallician miners make bronze? For this is generally the compound indicated by the Roman *æris metalla*, though it is undoubted that they also knew of, and distinguished zinc brass. There is, I believe, no instance of a single bit of pure tin or pure copper being found with the numerous 'celts,' which occur in so many parts of England; nor is any other proof given that the direct union of tin and copper was effected by the natives of Britain. Copper is so abundant in Cornwall that it might tempt to the other hypothesis; but this copper is a sulphuret; it is found united to the sulphuret of iron, in deep veins, and in a matrix of quartz; and these are things which render the production of pure copper one of the most refined operations in smelting. Cæsar tells us the brass used by the natives of Britain was imported. Probably Cyprus,—colonized by the Phœnicians, to which old authors refer as the original source of brass—Cyprus with its ancient copper mines (Tamassus), which has given its name to the metal, might be one of the points from which bronze radiated over the Grecian, Roman and barbarian world. It was from Cinyras, the king of Cyprus, that Agamemnon received his splendid breastplate with twenty plates of tin, and its liberal additions of turquoise, lazulite, or rather malachite, obtained perhaps from the soil of the island. (Pliny, xxxiii, p. 633, Hard.)

The works of Ἡφαιστος, the Crawshay of antiquity, may have been fixed on Lemnos on account of some volcanic appearances there; but the tradition shows at least that the various operations of refined metallurgy were not strangers to the islands of the Mediterranean; and the uniformity of design and composition in the ancient celts, chisels, μάχελλα, and instruments of war, implies a common, and that not a barbarous origin. The perfection and variety and great proportions of the brass work executed in the Grecian states and colonies, may also be regarded as indicating the local seat of the early as well as the later art of working in bronze.

Lead was obtained in Spain and Gaul from deep and laborious mines (xxxiv, p. 669, Hard.), but so abundantly near the surface in Britain as to suggest a law for preventing more than a limited production—a Brigantian law of vend. The Romans employed lead in pipes (fistulæ) and sheets, which were soldered with alloys, as already mentioned. This lead was previously refined,

and its silver removed; the silver indeed being often the object of the enterprise. How earnestly silver was sought—how well the mining operations were carried on by the 'old men'—appears from the notice of the Carthaginian mines in Spain, the pits and levels driven by Hannibal being mentioned as in wonderful preservation by Pliny. The same may be said of at least one set of mining works of Roman date, in the extreme parts of South Wales, viz., the Gogofau near Lampeter, where gold was extracted with much labor from broken and pounded quartz, of which enormous mounds remain. The adit still exists, and was lately entered by Sir H. T. De la Beche, who found in it a specimen of native gold. In the vicinity, tradition indicates a Roman settlement; and a massive chain of gold and other remains were found, and are now possessed by the family of Johnes of Abercothi.*

The districts in Britain, where lead veins coming to the surface in abundance might justify the praises of Pliny, are, in the south, Mendip; in the west, Flintshire, &c.; in the north, Derbyshire, Yorkshire and Cumberland, that is to say, the Brigantian territory: and it is to this last district that the descriptions apply most correctly. Lead cast in Roman moulds, pigs, in fact, of the age of Hadrian and other emperors, have been found in Flintshire, Derbyshire, Yorkshire, and some other counties. But few ancient mining instruments have ever been found in the lead-bearing districts of Britain;† and I am strongly of opinion that much of the lead ore was collected from the surface by aid of water, artificially directed. The process, in fact, is described by Pliny in terms so exactly applicable to the modern 'hushes' of Swaledale, that no doubt can remain of this custom, which is now esteemed rude and semi-barbarous, being of Roman or earlier date in Britain.

As thus from Roman or earlier times our lead-mining derives its 'hush,' its levels, and shafts, implements for washing, and other processes of the workmen, and the forms, weights, and marks of its melted metal, we may easily admit a similar origin for the melting process. Lead mostly occurs in the sulphuret, which offers no particular difficulty in the fire. By cautious roasting, its excess of sulphur may be removed, and the subsequent melting with charcoal, or a flux, be facilitated. Indeed without roasting, and without flux in many cases, the lead will flow out of the ore, if placed among flaming wood or peat, and subjected to a sufficient stream of air.

But the use of fluxes could not long remain unknown in the limestone districts of Northumbria, or amid the fluoric veins of

* See Sir R. I. Murchison's remarks on Gogofau (Sil. Syst., p. 367, 368).

† Sir R. I. Murchison mentions Roman mining utensils at Shelve in Shropshire (Sil. Syst., p. 279).

Derbyshire—limestone and fluor being to this day valuable aids in the furnace. Peat was the fuel in Cornwall, and still is in Yorkshire; and perhaps the Roman smelters did really erect their furnaces on waste ground and heaths at Dacre and Matlock, far from the mines of Greenhow and Youlgreave, even as is done at present with the cupolas of Lee and Langley mills.

The use of crucibles (*χόανοι*), bellows, cavities of some peculiar sort (*κάμινοι*), perhaps chimneys, great variety of carbonaceous fuel, the power of purifying and alloying, and knowledge of the properties of alloys, appear quite conspicuous among the ancient arts.

The inscriptions* on these masses of lead are in the same general form as the 'marks' of the different mines now in work, and which, no doubt, are their literal and lineal descendants. Thus the Ald or Auld Gang mine of Swaledale, old in the days of the Saxons; the mines of Greenhow Hill, which supplied sheet and pipe lead for our baths and coffins at York, as well as tribute to the imperial treasury; the mines of Middleton and Youlgreave (Aldgroove), from which the Lutudæ sent not only lead, but 'exargentate' (that is to say refined) lead from which the silver had been removed, use to this day the pig of the same weight of $1\frac{1}{2}$ cwt., of similar shape and similar mark to that of 1800 years antiquity.† And just as at the present day, the countryman whose galloway is tired drops the leaden load by the way side, for another day's work, so in the days of Rome, the Brigantian lead

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* The following inscriptions have been recorded on pigs of lead obtained from British mines during the Roman sway in Britain. It will be remarked that they belong to early imperial times.

IMP. CAES. DOMITIANO. AVG. C. C. S·VII. Found at Hagshaw Moor, Dacre Pasture, near Pately Bridge, Yorkshire, in 1734.

A Roman pig of lead, weighing 126 lbs., was found on Cromford Moor, near Matlock, in the year 1777, having the following inscription in raised letters on the top:

IMP. CAES. HADRIANI. AVG. MET. LVT.

A second was discovered near Matlock in 1783. It weighed 84 lbs., and was 19 inches long at top, and 22 at bottom. Its width at top was $3\frac{1}{2}$ inches, and at bottom $4\frac{1}{4}$. The inscription appears to contain these letters:

L. ARVCONI. VERECVND. METAL. LVTVD.

A third, with the inscription also in raised letters on the top, was found in Matlock Moor in the year 1787. It weighs 173 lbs., and was $17\frac{1}{2}$ inches in length, and at bottom $20\frac{1}{2}$.

TI. CL. TR. LVT. BR. EX. ARG.

Glover's Derbyshire, vol. i, p. 71, 72.

A fourth is stated to have been found at Castleton, on which only the letters IMP could be read distinctly. It was said by Mr. Mawe to be preserved in the museum of Mr. Green at Litchfield.

Sir R. I. Murchison records a Roman pig of lead (from the Shelve mines in Shropshire probably), bearing the inscription, IMP. ADRIANI. AVG. (Sil. Syst., p. 279.) This pig is said to be unlike the modern pig.

† The modern pig is made near to $\frac{2\,2\,2\,0}{1\,6}$ of a fodder or $176\frac{1}{4}$ lbs. Three Roman pigs found near Matlock in 1777, 1783, 1787, weighed 173, 126, and 84 lbs., these being as 1, $\frac{3}{4}$, and $\frac{1}{2}$ of the modern pig.

was thrown down from the tired caballus by the side of the ancient mining road, on Matlock Moor in Derbyshire, and Dacre Pasture in Yorkshire.

This fact of the discovery of the Roman lead, *not at the mines*, but at a distance of some miles from them on a track leading *towards* a Roman or rather a Pre-Roman station, is of much importance in archæology. For thus we arrive, in the first place, at the conviction of the existence of very ancient mining roads not of Roman work, nor probably of Roman but of earlier date, leading toward Cataractonium, Isurium, Eburacum, Mancunium, Derventio, or rather to the Brigantian towns or centres of trade, on which the Romans following their wont in Africa, Spain, and Gaul, fixed their attention and established their war camps and their colonies. The politic lords of the world broke up no national industry, set no legionaries to supplant the native miners, but stationing a few cohorts on the ancient roads, in or close to the mining district, as at Hope and Bainbridge, to control a rude population, received regularly the fruits of the industry which they might direct, but did not personally share. Viewed in this light, how complete appears the grasp of the Roman treasury on the mining fields of Britain! The Fossway from the Ocrynian promontory crosses the Mendip Hills—the road from Mancunium to Bremetonacum traverses the Calamine district of Bowland—the road from Derventio or Tutbury to Mancunium runs along the west of the great Derbyshire field, and the legionary path from Carlisle to York goes right across the metalliferous country of Yorkshire and Durham.

We may even ask with some confidence, whether the line of the Hadrian wall, which cuts off from the north all the richest mines of the Derwent, the Allen, and the Tyne, but abandons the mossy dales of bleak Northumbria, was not drawn with especial reference to the mining wealth of the districts.

May we not regard, as a confirmation of all that has been advanced touching the antiquity of our mining processes, the fact of the existence to this day, though impaired by recent acts of parliament, of peculiar rights and privileges in the mining districts? These rights are sometimes guaranteed by and appear to emanate from royal charters, as in the stanneries of Cornwall and Devon, but they are probably of far earlier date, and have merely been confirmed as old customs by John and his successors. In Mendip, the Forest of Dean and Derbyshire, the miners' rights were preserved by royal officers, but the rights themselves transcend all history and tradition. To sink a pit or drive a level in any field; to cover the rich herbage with barren ore-stuff; to cut a way to the public road; to divert, employ, and waste the running waters; and to do all this without consent of owner, and without compensation being so much as asked by lord or villein, landlord or

tenant, implies in Derbyshire a settlement of mining rights long anterior to Domesday Book, the charters of Repton Abbey*, the neighing of the Saxon horse, and the flight of the Roman eagle. In connection with all that has been mentioned before,—the furnaces, the roads, the restricted vend, the foreign trade—they seem to me to indicate a people who came with many inventions from the metalliferous east to the metalliferous west, before the Athenians drew silver from Laurion, or the Carthaginians from Iberia.

To these ancient, these Semitic mining processes we have added perhaps steel instruments, and certainly explosive agents; the ore-hearth still remains, but it is generally yielding to the reverberatory furnace; silver is no longer obtained by oxydation of some thousand times its weight of lead; steam blows our furnace fires, rolls and pipes our metals, and flies with iron wings on roads more solid than the Appian Way. The world of George Stephenson is much different from that of Julius Agricola; but some features of the past remain to connect the earliest with the latest aspect of our country: and among these the least altered, and the most instructive, appear to be the mineral products and the mining processes. If by these we judge the great Brigantian tribes which surround Isurium, they must be placed far higher on the scale of civilization than the place usually accorded by the Saxon to the Celt.

I presume to think, indeed, that without full attention to the mining history of Britain, as indicated by fragments in classic authors, and illustrated by processes not yet extinct, the opinion which may be formed of the ancient British people would be altogether conjectural, derogatory, and erroneous.

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* The mines in the neighborhood of Wirksworth were wrought before the year 714; at which period that district belonged to the nunnery at Repton, over which Eadburga, the daughter of Adulph, king of the East Angles, presided as abbess. In that year the abbess sent to Croyland, in Lincolnshire, for the interment of St. Guthlac, who was originally a monk of Repton, a sarcophagus of lead lined with linen (plumbum lintheumque). This lead was obtained from the possessions of the old Saxon religious establishments at Repton, part of which were the mines near Wirksworth. In the year 835, Kenawara, then abbess of the same nunnery, made a grant to Humbert, the alderman, in which she surrenders that estate of mines, called Wircesworth, on condition that he gives annually, as a rent to Archbishop Ceolnoth, lead to the value of 300 shillings, for the use of Christ's Church, Canterbury. On the destruction of the religious houses by the Danes in 874, it is probable that the lead mines became the property of the Crown. As such they are mentioned in Domesday Book.—*Glover's Derbyshire*, vol. i, p. 73.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On Margaritinic Acid;* by Louis Saalmueller, (communicated for this Journal, by M. Schleiper.)—During my stay in Giessen, I occupied myself with the investigation of castor oil, but from want of time, and material, I was prevented from studying more closely the solid fat acid of this oil. Since that time I have had occasion to procure larger quantities of the sediment deposited from castor oil, which has enabled me to investigate more exactly the qualities of the margaritinic acid. In spite of the great difficulties which offered themselves, in the way of obtaining this acid of a constant melting point, I think I am enabled to state it pretty accurately. From 5 pounds of the above mentioned precipitate, treated according to the method which I have described in my former paper on this subject, (Annalen der Chemie und Pharmacie, vol. lxiv, p. 108,) I obtained only 10–12 grammes of the solid acid. The melting point of the solid acid, free from alkalies, was at first 25° C.; but by more than twenty recrystallizations, I succeeded in getting an acid which melted at 51° C., and which melting point remained constant,—at least, it did not change any more at the three last crystallizations.

Bussy and Lecanu called this acid margaritinic acid, from its pearly lustre. It was obtained as mentioned previously, by saponification of the oil, separation of the fat acids by means of monobasic acid, and mixture of the fluid fat acid with $\frac{1}{3}$ alcohol. By keeping this mixture a longer time at a temperature below the freezing point, the separation of the solid acid commences, but mixed with bicinoleic acid in combination with potassa. To purify the crude acid it is necessary to press it repeatedly between blotting paper, and recrystallize it many times from alcohol, adding small quantities of muriatic acid, to separate the strongly adhering potassa. The white mass swimming on the surface was then filtered off, washed out, pressed between paper and dissolved in strong alcohol; this solution by means of spontaneous evaporation, then deposits the acid in white globular aggregates, sometimes in fine crystallized white shining plates. These crystals dissolve easily in alcohol and ether, have a slight acid reaction and burn with a bright, shining, blackening flame; the remaining coal burns easily without leaving any residue. The acid cannot be distilled without decomposition; the distillate which I obtained, had a melting point of 54° C., was colored yellow, and in the retort there remained a light spongy coal.

The analysis of this acid gave the following numbers:*

I. 0·3525 grm. acid burnt with chromate of lead, gave 1·0025 grm. carbonic acid and 0·4145 grm. water.

II. 0·235 grm. acid gave 0·6715 grm. CO_2 and 0·265 grm. HO.

III. 0·256 " " " 0·7372 grm. CO_2 and 0·2972 grm. HO.

* According to my previous investigations, the melting point, just as well as the amount of carbon of the solid acid, seems to change, in the different sorts of castor oil, which supposition is more strongly confirmed, by my present investigation.

Out of these numbers the following empiric formula for margaritinic acid hydrate may be described:

$$C_{60}H_{59}O_5.$$

	Calculated.		Found.		
			I.	II.	III.
C_{60}	300	78·43	77·56	77·97	78·54
H_{59}	59	12·85	73·06	12·52	12·90
O_5	40	8·72	9·38	9·51	8·56
$C_{60}H_{59}O_5$	459	100·00	100·00	100·00	100·00

Fused with oxyd of lead it diminished in weight, and gave water on heating it in a test-tube.

The formula of the anhydrous acid would accordingly be—

$$C_{60}H_{57}O_3$$

and the hydrate:

$$C_{60}H_{57}O_3+2HO,$$

containing two equivalents of basic water which can be replaced by bases.

Margaritinate of Potash.—This salt was obtained by saponification of the acid with an excess of potassa, which process took place very rapidly; after a few hours' standing, the potash salt separates from the clear filtered soap solution as a soft cake. After washing it with cold water, and pressing it between filtering paper, it dissolves easily in hot alcohol, and separates itself on cooling in small white indistinct crystals. This salt so obtained, was dried over sulphuric acid and in the water bath, but remained unaltered; on analyzing it, the following numbers were obtained:

I. 0·544 grm. potash salt gave 0·168 grm. sulphate of potash =0·090866 grm. potassa.

II. 0·421 grm. potash salt gave 0·137 grm. sulphate of potash =0·07409 grm. potassa.

These numbers conduct to the formula:

$$C_{60}H_{57}O_3+2KO$$

as results from the comparison of the found and calculated values:

	Calculated.		Found.		
			I.	II.	Average.
1 equiv. marg. acid,	=441	82·40			
1 " potassa,	= 94·23	17·60	16·70	17·60	17·15
	535·23	100·00	100·00	100·00	100·00

Margaritinate of Silver.—The best method to prepare this salt, is, to dissolve the margaritinate of potash in alcohol, to dilute the solution a little with water, and to decompose it with a solution of nitrate of silver; it forms a light, white and curdy precipitate, becoming brown, by exposure to the light, more so in drying it over sulphuric acid or in the water-bath. This salt is easily soluble in ammonia and partly so in water and alcohol. By analysis I obtained the following numbers:—

I. 0·1674 grms. silver-salt gave 0·0535 grm. silver.
II. 0·1715 " " " 0·055 " "
III. 0·161 " " " by combination 0·310 grm. carbonic acid and 0·126 grm. of water.
IV. 0·1845 grm. silver-salt gave 0·3561 grm. carbonic acid and 0·1445 grm. water.

According to these values, the following formula is calculated for the silver-salt:

$$C_{60}H_{57}O_3+2AgO.$$

	Calculated.		Found.	
			I and III.	II and IV.
60 C	360	53·48	52·51	52·62
57 H	57	8·47	8·69	58·70
3 O	24	4·58	4·47	4·16
2 AgO	232	34·47	34·33	34·52
$C_{60}H_{57}O_3+2AgO=$	673	100·00	100·00	100·00

The slight loss in carbon will be easily accounted for, when the small quantity of substance which I was enabled to submit to analysis is taken in consideration.

Margaritinate of Barytes.—Notwithstanding all the pains I took, I did not succeed in obtaining this salt of a constant composition. The precipitates partly obtained by decomposition of a watery solution of the soap with chlorid of barytes, partly by precipitating the alcoholic solution of the potash salt in the same way, formed a white, curdy, voluminous mass, soluble in alcohol and ether, insoluble in water, and which was not altered by exposure to a temperature of 100° C.

Margaritinic ether was easily produced by introducing a stream of hydrochloric acid gas into an alcoholic solution of the acid in question; the ether separated at the surface of the liquid in yellow oily drops, becoming crystalline in cooling. After having washed them repeatedly with water, they had a melting point of 32° C. The quantity obtained was too small to allow of an organic analysis.

2. *On some New Phenomena of Light and Actinism;* by Mr. Hunt, (Proc. Roy. Soc., Athen., No. 1122.)—The chemical change produced in chlorid of silver when exposed to the action of the sun's rays, by which powerful chemical affinity is broken up, chlorine liberated and silver in a state of fine division left, was selected as an exemplification of the actinic force, which was the subject of consideration. This chemical change takes place in white light, and hence all those photographic phenomena which have created so much interest have been referred to luminous power. If, however, we examine the conditions of light as analyzed by the prism,—presenting not seven colored bands as stated by Sir Isaac Newton, but *nine* as proved by recent experiments,—it is found that these colored bands possess opposite properties. For instance, the chlorid of silver will not darken in the mean luminous ray of the spectrum, nor will it darken either at the end which gives the greatest calorific effect, or at the end which is embraced by the lavender ray, usually regarded as representing the most chemically active part; consequently we find three points in the spectrum which will not

produce any change in chlorid of silver. Where we have the most light, and at two extremities where the light ceases to affect the human eye, and also laterally bands are exhibited which show the same physical conditions, and thus it would appear that the *circle of light* is not the agent producing this peculiar alteration. Regarding, as appears natural, the ordinary prismatic spectrum as the representation actually of two spectra consisting of but three colors—red, blue and yellow, which is shown by the reappearance of red light in the blue and of yellow light in the lavender ray, which blue light appears again at the least refrangible end in the extreme red or crimson ray, we have an explanation of the result above mentioned, and the want of chemical action is shown to arise from the operation indeed of the most luminous bands. By absorbent media, as colored glasses and fluids, these results were more fully explained. The most remarkable results have, however, been lately obtained by the use of colored media; and it has been shown that every luminous ray, independent of color, may be made to protect chlorid of silver from that chemical change which is induced by the direct action of diffused daylight,—the portion upon which those rays fall being actually preserved as a white space, every other part being blackened. It was contended that no hypothesis of interference would explain this result, which more decidedly proved than had hitherto been done the wide difference between the phenomena of light and actinism. The fact that luminous effect—phosphorescence—was produced by the blue rays of the spectrum appears to oppose this view; but when we find that almost any variety of glass prevents this phenomenon, and that in like manner electricity was interrupted, it appears more rational to refer phosphorescent phenomena to some peculiar electric excitation. The action of the solar rays on the development of vegetable life was then explained, and the following conclusions suggested as the explanation of experimental results frequently repeated:—1. *Germination*, which will take place in the dark, is quickened by the actinic force, and retarded and often stopped by the luminous power.—2. *Lignification.* The decomposition of carbonic acid by the plant is due to some excitement of luminous power and is stopped by the actinic force.—3. *Formation of Chlorophyle.* Due entirely to the luminous rays.—4. *Flowering and Fruiting.* Dependent upon the action of the thermic or parathermic rays of the spectrum, as distinguished from both the luminous and actinic forces.—5. *Motion of Plants.* Bending to the blue light and receding from the red, proving the excitement of actinic force.

3. *On the direct production of Heat by Magnetism;* by W. R. Grove, Esq., (Proc. Roy. Soc., Athen., No. 1131.)—The author recites the experiments of Marrian, Beatson, Wertheim and De la Rive on the phenomenon made known some years ago, that soft iron when magnetized emitted a sound or musical note. He also mentions an experiment of his own, where a tube was filled with the liquid in which magnetic oxyd had been prepared, and surrounded by a coil; this showed to a spectator looking through it an increase of the transmitted light when the coil was electrized. All these experiments the author considers go to prove that whenever magnetization takes place a change is produced in the molecular condition of the substances magnetized; and it occurred to him that if this be the case a species of molecular

friction might be expected to obtain, and by such molecular friction heat might be produced. In proving the correctness of these conjectures difficulties presented themselves, the principal of which was that with electro-magnets the heat produced by the electrized coil surrounding them might be expected to mask any heat developed by the magnetism. This interference the author considers he eliminated by surrounding the poles of an electro-magnet with cisterns of water, and by this means, and by covering the keeper with flannel and other expedients, he was enabled to produce in a cylindrical soft-iron keeper when rapidly magnetized and demagnetized, a rise of temperature several degrees beyond that which obtained in the electro-magnet, and which therefore could not have been due to conduction or radiation of heat from such magnet. By filling the cisterns with water colder than the electro-magnet, the latter could be cooled while the keeper was being heated by the magnetization. The author subsequently obtained distinct thermic effects in a bar of soft iron placed opposite to a rotating permanent steel magnet. To eliminate the effects of magneto-electrical currents, the author then made experiments with non-magnetic metals and with silicoborate of lead, substituted for the iron keepers, but no thermic effects were developed. He then tried the magnetic metals nickel and cobalt, and obtained thermic effects with both, and in proportion to their magnetic intensity. Some questions of theory relating to the rationale of the action of what are termed "the imponderables" and to terrestrial magnetism then were discussed; and the author concluded by stating that he considers his experiments prove, that whenever a bar of iron or other magnetic metal is magnetized its temperature is raised.

4. *Glonoine.*—It is now more than two years since M. Sobrero first announced the discovery of this body by the action of nitro-sulphuric acid upon glycerine.* When a mixture of two volumes of sulphuric acid, sp. gr. 1·838, and one of nitric acid of 1·43, is surrounded by a freezing mixture, and syrupy glycerine is slowly added with constant agitation to prevent an elevation of temperature, it dissolves without any escape of gas. From this solution, water precipitates the new compound in the form of a heavy yellow oil which may be washed without loss, as it is quite insoluble in water. By solution in alcohol and precipitation by water, it is obtained pure with the exception of a little moisture which may be removed by exposing it *in vacuo* over sulphuric acid. It is inodorous, but sweet, pungent and aromatic to the taste. The smallest portion placed upon the tongue was found to produce a violent headache, and the discoverer recommends the greatest care in its preparation. He did not submit it to analysis, but from the mode of its formation, it is probably a nitric species of glycerine.

The physiological action of this substance is most extraordinary; the observations of M. Sobrero having attracted the attention of Dr. Hering of Philadelphia, he with some other medical gentlemen of that city have made a series of experiments with it, upon men and the lower animals.† As the discoverer had not named the new body, Dr. Hering,

* See Chem. Gazette, May, 1847, from Compt. Rendus, Feb. 17th, 1847.

† American Journal of Homœopathy, May, 1849, from which, in part, the following details are taken.

regarding it as a compound of oxyd of glycyl with nitrous acid, proposed for it the name of *glonoine* from the symbols of those substances with the termination *ine;* this is objectionable as tending from a similarity of termination to confound it with the alkaloids, but may serve until farther investigations shall have determined its composition and its real nature. When taken in small doses its effect is an almost immediate acceleration of the pulse with giddiness and a sense of fullness and pressure in the frontal region, followed by a severe headache, which is often confined to the coronal region, sometimes to one side of the head and attended with twitchings of the muscles of the face, throbbing of the temporal arteries, and sometimes a difficulty in articulation. The pain is greatly aggravated by motion and on shaking the head is almost intolerable. These symptoms subside spontaneously in a short time and are often succeeded by a diminished pulse and a feeling of soreness and heaviness about the head.

The most extraordinary feature connected with these observations is the very minute quantity required to produce the effect described. In the experiments of Dr. Hering one drop of the glonoine was placed in a bottle to which 5000 globules of milk-sugar were added, and by agitation the whole were impregnated. The number of these globules required to produce the symptoms above described is from 5 to 20, 50 and in some individuals 200. The majority of persons experience the symptoms in a marked degree, after having taken $20 = \frac{1}{250}$th of a grain, and many susceptible subjects are painfully affected by $5 = \frac{1}{1000}$th of a grain. The lower animals are less sensible to its action; ten drops were required to destroy a frog; four drops given to a cat produced convulsions, but the animal recovered; another cat was killed by three drops. The strongest dose taken by a man has been $\frac{1}{10}$th of a drop. Common coffee is found to be an antidote to the unpleasant effects of an over dose.

A substance of such unexampled potency in its action upon the human system, can scarcely be without use in the treatment of disease, and Dr. Hering with several other of the homœopathic physicians in Philadelphia is at present occupied in proving it by a careful examination of the various symptoms produced by it under different circumstances and in different doses. T. S. Hunt.

Montreal, May 20th, 1849.

5. *On the Action of Alkalies and Acids upon Aldehyde;* by H. Weidenbusch, (Ann. der Chim. und Pharm., in Chem. Gaz., Jan., 1849.)—That aldehyde was revivified by alkalies,—blackened by sulphuric acid and converted into acetic acid by nitric acid—was the sum total of our knowledge on this subject until the present investigation, the results of which are as follows.

Potash in acting upon aldehyde beside producing the ordinary resin, gives rise to an irritating odor due to a thick yellow oil with an odor of cinnamon. This oil by its rapid oxydation produces a resin different from common aldehyde resin, and containing a large per cent. of oxygen; at the same time the action of alkalies seems to form from the aldehyde, acetic and formic acids.

Action of Acids.—Aldehyde with half its bulk of water and a trace of sulphuric or nitric acid, on cooling to 32°, separates into fine crys-

tals of the metaldehyde of Liebig, and a liquid insoluble in water which when purified proves to be a new modification of aldehyde. The density of vapor is the same as that of elaldehyde; its properties are however different. It is a thin acrid liquid soluble in alcohol and ether, slightly in water, boils at 257° and changes rapidly into a crystalline acid not yet examined. It is quite curious that with heat a trace of sulphuric acid reconverts this modification into common aldehyde. The same acid thus forms the substance and reconverts it as we use a high or low temperature.

Action of Sulphureted Hydrogen.—A large quantity of this gas passed through a mixture of aldehyde and water causes the deposit of a thick oil, with an insupportable garlic odor. To this oil is assigned the formula $C_{12} H_{13} S_7$—or elaldehyde with S instead of O, and united to HS, although the analysis agrees well with this—the oil does not seem to be a definite compound—its boiling point, 356°, continually rises. It absorbs ammoniacal gas and produces thialdine.

From this oil, by exposure to the air, or by the action of acids, is formed a substance called by the author acetylic mercaptan $C_4 H_4 S_2$, or aldehyde with S_2 instead of O_2. [It is more probably the sulphur species of elaldehyde and from it thialdine is immediately derived by NH_3 replacing S_2. We have noticed a similar garlic odor on the decomposition of thialdine, and it is not improbable that with an excess of sulphureted hydrogen, both substances may be formed at the same time.]

G. C. Schæffer.

6. *On an Organic Compound containing Arsenic;* by Prof. Wöhler, (Liebig's Annalen in Chem. Gaz., Feb., 1849.)—Dry distillation of a mixture of butyrate of potash and arsenious acid, produced a liquid, which when purified strongly, resembled alcarsin in odor and other properties, but did not ignite spontaneously. The experiment was considered to prove the formation of alcarsin or some analogous compound.

G. C. S.

7. *On Liquid Protoxyd of Nitrogen;* by M. Dumas, (Comptes Rendus, Nov., 1848.)—The apparatus used for liquefying this gas, was the forcing pump of M. Natterer of Vienna, strengthened by a belt of wrought iron, and supplied with a contrivance for cooling the body of the pump and even the piston rod, by the circulation of cold water. Thus arranged, the apparatus is capable of condensing, in two hours, 200 litres (53 gals.) of the gas, which must be pure and quite dry. The condensation of 20 litres produces the pressure of 30 atmospheres, the remainder furnishes the liquid. Two pounds of nitrate of ammonia are sufficient for the experiment.

The liquid may be retained in the reservoir for one or two days with but trifling injury to the valve. The first portion which is allowed to escape becomes solid, the remainder and larger part is liquid and may be kept in the air half an hour or longer. Protoxyd of nitrogen is thus found as a clear colorless very mobile liquid; every drop that touches the skin produces a severe burn; metals dropped into it hiss like red hot iron; quick-silver is instantly frozen, as are also sulphuric and nitric acids; ether and alcohol are not frozen by it; water is instantly frozen and produces by sudden evaporation of the liquid, a sort of explosion.

Potassium, phosphorus, sulphur, iodine and charcoal, float upon this liquid without change. Ignited charcoal floats and burns with great brilliancy. G. C. S.

8. *On Anhydrous Nitric Acid;* by M. DEVILLE.—This remarkable substance is obtained by a simple process. Perfectly dry chlorine is passed over equally dry nitrate of silver; no action takes place at ordinary temperatures, but the nitrate must be heated at first to 203° F. and then lowered to 140°–150°; the decomposition then proceeds quite regularly. At first hyponitrous acid is formed, but on lowering the temperature the new substance is deposited in crystals, in the cooled part of the apparatus, although a cold of 6° was employed to condense the vapors, the crystals were found to form when ice alone was used. The vapor of the anhydrous nitric acid penetrates caoutchouc tubes with such ease, that it is necessary that all parts of the apparatus through which it passes should be solidly joined at the blowpipe. Colored vapors are given off throughout the operation and the decomposition does not seem to be quite definite.

The *anhydrous nitric acid* forms large, brilliant, colorless crystals in six-sided prisms of the trimetric system. The melting point is 85°, the boiling point 113°. With water much heat is evolved and solution takes place without the escape of gas; the solution forms nitrates. Decomposition takes place so near the boiling point of the crystals that the density of the vapor cannot well be determined.

On attempting to recrystallize the substance in a sealed tube in which it had been suffered to liquefy, a violent explosion took place. Probably the substance had decomposed gradually into hyponitric acid and oxygen, and the tension of the latter caused the accident.

[The claims of this remarkable substance, to the name of *anhydrous nitric acid*, seem somewhat doubtful, although there can be no doubt as to its composition. The further investigations of M. Deville may give us new light.

In some investigations of M. Kuhlman on the action of the anhydrid of sulphuric acid on nitric acid, a reaction took place closely resembling that above described, and *white* crystals were formed which seem not to have been examined. Having merely an abstract of the paper before us, it is impossible to decide whether these were identical with the anhydrous nitric acid of M. Deville, or only a compound of sulphuric and nitrous acids.] G. C. S.

9. *On the Composition of Stearic and Margaric Acids;* by Messrs. LAURENT and GERHARDT, (Comptes Rendus, March, 1849.)—The composition usually assigned to these acids, makes them two different oxyds of the radical, analogous to the arrangement in hyposulphuric and sulphuric acids—the acids are supposed anhydrous.

The authors were led to doubt these formulas, because the acids have a strong resemblance in their physical properties, their metamorphoses under various reagents are identical, and moreover the formula assigned to stearic is at variance with the well known principles laid down by the authors.

The results of experiment showed, as has generally been allowed, that the atomic weight of the two acids is the same. Seven analyses of stearic acid derived from four different sources gave results strikingly

concordant and affording exactly the formula for margaric acid, $C_{34}H_{34}O_4$ ($C_{17}H_{34}O_2$, Ger.)

The statement of Chevreul, that stearic acid may be distilled without change, is also confirmed. If the melting point is changed in the product, it is owing not to a decomposition but merely to a molecular change.

This discovery which places stearic and margaric (metastearic) acids in the same relation with tartaric and racemic (metatartaric) acids, greatly simplifies the whole of a hitherto intricate subject, explains the identity of margarone and stearone, &c., and above all, does away with the difference between the fat of man and the pig and that of other animals, a result highly important to physiology. G. C. S.

10. *On Caprylone;* by G. Göckelberger, (Liebig's Ann., Feb., 1849, in Chem. Gaz.)—This is a new body of the acetone series—obtained from the baryta salt of the caprylic acid from cocoanut oil. In forming this and the similar bodies, the decomposition is not always simple, but in the case of caprylone an excess of hydrate of lime with the baryta salts, raised rapidly to a red heat, was found to furnish the purest product. By pressure in filtering paper, washing with cold alcohol and crystallizing from hot alcohol, caprylone may be obtained in a state of purity. It is white like wax in appearance and smell, insoluble in water, soluble in ether and oils, and even to some extent in cold alcohol. Boiling alcohol and pyroxylic spirit dissolve large quantities. It melts at 104°, solidifies at 100°, and boils at 352° without decomposition.

Caprylic acid being $C_{16}H_{16}O_4$, caprylone is given by the author as $C_{15}H_{15}O$: it should be $C_{30}H_{30}O_2$, to agree with acetone as referred to 4 volumes of vapor,—acetic acid being $C_4H_4O_4$, acetone $C_6H_6O_2$ (Dumas). G. C. S.

11. *Composition of Bone Earth;* by Dr. W. Heintz, (Berlin Bericht, Feb., 1849, in Chem. Gaz.)—On the authority of Berzelius, the phosphate of lime in bones has usually been stated as $8CaO, 3PO_5$—but others have doubted the accuracy of this rather extraordinary formula.

On examination, Dr. Heintz found the carbonic and phosphoric acids insufficient to combine with all the lime and magnesia. This excess of base was exactly accounted for on estimating the fluorid of calcium—on subtracting this and the carbonate of lime, the remaining lime and magnesia were found to represent the ordinary tribasic phosphate $3RO, PO_5$. No iron was found in the bones exhausted with water, its supposed presence in bone arising probably from the coloring matter of the blood. G. C. S.

12. *On the reaction of Iron and Zinc with Anhydrous Sulphuric Acid and with Sulphates;* by A. D'Heureuse, (Poggendorff's Ann. in Chem. Gaz.)—With anhydrous sulphuric acid at a red heat, iron is converted into a mixture of proto-, and per-oxyd and proto-sulphate. Zinc is also converted into oxyd and sulphuret.

With sulphate of potash at a red heat, iron produces a complete decomposition of the sulphuric acid, and the residue contains oxyd and sulphuret of iron with caustic potash; no sulphuret of potassium is formed. Pure caustic potash cannot, however, be obtained by this process as on solution in water some sulphuret of iron is taken up. The

author states, however, that crude carbonate of potash may be freed from sulphur by fusing in the finely divided iron.

With zinc, sulphate of potash produces sulphuret of potassium and oxyd of zinc. With sulphate of soda, the reaction of zinc and iron is similar to that stated above.

Sulphate of baryta is decomposed into sulphuret of barium and more readily than by charcoal; the whole cannot, however, be extracted by hot water.

The following process is said to furnish very good chlorid of barium. Heat to redness two parts sulphate of baryta, two of iron, and one of chlorid of calcium—reduce the mass when cold to powder—and exhaust by boiling water, add a few drops of muriatic acid and evaporate. Too high a temperature is injurious.

Zinc treated with sulphate of baryta furnishes a compound not easily acted on by hot water.

The decomposition of sulphate of strontia requires a much higher heat, but is otherwise similar to that of the baryta salt. G. C. S.

13. *Hydrated Valerianate of Zinc.*—Wittstein has found that this salt when prepared from carbonate of zinc, poured into a part of the water into which the requisite quantity of acid is stirred—is no longer anhydrous, but contains 12 equivalents of water or 44·5 per cent., which it loses at 212°. This observation is important, as this valuable medicine may be given in but half the quantity intended. The two salts are moreover said to be identical in appearance. G. C. S.

14. *On the Passage of Hydrogen gas through solid bodies;* by M. Louyet.—This author, in a communication to the Brussels Academy, has shown that hydrogen gas passes with facility through paper and also gold and silver leaf. On directing a stream of the gas against one side of the leaf it may be lighted on the other.

15. *On Emulsine;* by B. W. Bull.—In the memoir by Mr. Bull in this volume, the formula is given, page 86, as $C_{36}\,H_{35}\,\dot{N}_4\,(O+S)_{24}$. After the manuscript was sent from Giessen, as the author writes, he was led by the advice of Liebig to change it to $C_9\,H_9\,N\,(O+S)_6$, —which is one-fourth the above with a slight change in the hydrogen—and it is thus printed in Liebig's Annalen. This formula gives the calculated percentage,

C_9	43·20
H_9	7·20
N	11·20
S+O	38·40=100

From a calculation by Strecker the proportion of sulphur is expressed by the formula $10\,(C_9\,H_9\,NO_6)+S$.

II. Mineralogy and Geology.

1. *On Chloritoid and Masonite;* by J. D. Whitney, (Proc. Bost. Soc. Nat. Hist., Jan., 1849, p. 100.)—The true chemical composition of the substance called chloritoid is a matter of some uncertainty. Bonsdorff, who, according to G. Rose, undoubtedly analyzed the real

chloritoid, in which water was an essential ingredient, gave as the result of his analysis,

$$(\dot{Fe}, \dot{Mg})^3\,\ddot{Si} + \ddot{\mathbf{A}}l^2\,\ddot{Si} + 3\dot{\mathbf{H}};$$

the ratio of the oxygen of $\dot{R}$, $\ddot{\mathbf{A}}l$, $\ddot{Si}$ and $\dot{\mathbf{H}}$, being 7·88 : 16·61 : 14·27 : 6·17, for which he adopted the ratio 3 : 6 : 6 : 3. Rammelsberg has taken the ratio as 3 : 6 : 5 : 2, and gives for the formula of this mineral

$$3\,\dot{R}^3\,\ddot{Si} + 2\,\ddot{\mathbf{A}}l^3\,\ddot{Si} + 6\,\dot{\mathbf{H}},$$

which requires

$$\dot{Si}\ 25{\cdot}18,\ \ddot{\mathbf{A}}l\ 23{\cdot}61,\ \dot{Fe}\ 85{\cdot}31,\ \dot{\mathbf{H}}\ 5{\cdot}88 = 99{\cdot}98.$$

Erdmann has analyzed a mineral supposed to be the chlorite-spar or chloritoid described by Fiedler, and gives as the result of two analyses, agreeing closely with each other, the formula,

$$\dot{Fe}^3\,\ddot{Si} + \ddot{\mathbf{A}}l^3\,\ddot{Si}.$$

The substance analyzed by Erdmann did not contain water, and there seem to be two distinct substances, one of which is a hydrous silicate, and the other anhydrous. That the analysis of Bonsdorff was probably correct, is shown by the following analysis of the mineral described by Jackson as Masonite, which I find to have the same composition as the chloritoid of Bonsdorff, which it closely resembles in external characters.

The results of an analysis of Masonite were as follows:

		Oxygen.	Ratio.
Silica	28·27	14·55	3·2
Alumina	32·16	15·02	3·3
Protoxyd of iron	33·72	4·49	1·6
Magnesia	·13		
Water	5·00	4·44	1·
	99·28		

The ratio of $\ddot{Si}$, $\dot{Fe}$, $\ddot{\mathbf{A}}l$, and $\dot{\mathbf{H}}$, being nearly 6 : 3 : 6 : 2, the formula will be

$$\dot{Fe}^3\,\ddot{Si} + \ddot{\mathbf{A}}l^2\,\ddot{Si} + 2\dot{\mathbf{H}},$$

which is that given by Bonsdorff for chloritoid, with one atom of water less, which we may easily conceive to have been stated too high, if the mineral had not been carefully dried, especially as there is an excess of 1·6 per cent. in the analysis.

The formula given above requires

$$\ddot{Si}\ 28{\cdot}56,\ \ddot{\mathbf{A}}l\ 32{\cdot}06,\ \dot{Fe}\ 33{\cdot}60,\ \dot{\mathbf{H}}\ 5{\cdot}60 = 100{\cdot}02.$$

This, it will be seen, agrees very nearly with the results of analysis; I would therefore suggest that the name of Masonite should be retained for the hydrous chloritoid, as the formula given by Erdmann has been generally adopted for what is supposed to be the real chloritoid.

2. *Black Oxyd of Copper of Lake Superior;* (Ib., p. 102.)—Mr. Whitney made some remarks on the remarkable vein of black oxyd of

copper which was formerly worked at Copper Harbor, Lake Superior, but which was abandoned after some forty or fifty thousand pounds of this very valuable ore had been raised. It was the only vein of this substance, and perhaps the only locality known in the world, and specimens will be highly prized by the mineralogist hereafter. The substance called copper-black, and sometimes black oxyd of copper, which occurs in an earthy, pulverulent form, is not to be confounded with the pure oxyd of copper found at Copper Harbor. Copper-black is a mixture of various hydrated oxyds, especially of iron, manganese, and copper, of which the latter forms but a small portion; it occurs in an incrustation on other ores of copper, and is evidently the result of their decomposition. Semmola, however, has described a substance occurring in small tabular crystals, belonging to the hexagonal system, which, according to him, are pure oxyd of copper, Cu. To this substance he has given the name of Tenorite. The oxyd of copper found at Copper Harbor is generally compact, though the purer specimens have a crystalline structure. Mr. Teschemacher has, however, two specimens, which he has kindly allowed me to examine, in which this substance is distinctly crystallized in cubes, with their solid angles replaced. The question arises, was the substance described by Semmola as crystallized in the hexagonal system, really Cu, or is this substance dimorphous?

Some portions of the oxyd of copper from Copper Harbor are almost chemically pure, though it is generally mixed with a little silicate of copper. One of the purest specimens contained only 1·2 per cent. of impurities, mostly silica, with traces of lime and iron.

As the oxyd of copper of this remarkable vein has not been mineralogically described, the following description is added.

Substance tesseral, crystallized in cubes, with their solid angles occasionally replaced; generally, however, massive, with crystalline structure, sometimes earthy; no traces of cleavage. H.=3; G.=6·25; color, steel-grey to black; lustre, metallic, the earthy varieties acquire a metallic lustre on being scratched or cut with a knife; opaque. Chemical composition Cu, almost pure; containing copper, 79·86, oxygen, 20·13.

3. *On Arkansite.*—This mineral which Mr. J. D. Whitney makes out to be Brookite, has been examined by Mr. Teschemacher, (Proc. Bost. Soc. N. H., April, 1849, p. 132,) and he gives the following for its angles—see figure in this Journal, vol. iv, p. 279—M : M=100° and 80°. M : c=133° 35′, c : c=135° 45′, a : a=124°. Shepard made M : M 101° to 101° 15′, and a : a 123°. According to the measurements of Mr. Teschemacher, the angles are those of Brookite.

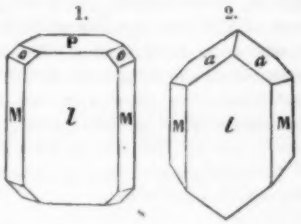
4. *Baïerine*, (L'Institut, No. 793.)—The metal pelopium has been found in the Columbite of Bavaria, by G. Rose, and in that of Limoges by Damour. It is proposed to distinguish this variety of Columbite by the name *baïerine* given it by Beudant. The specimens from these two localities agree well in external characters and in analyses.

5. *Notices of American Minerals;* by Prof. C. U. Shepard, (communicated for this Journal.)—*Pyrophyllite* in beautiful white *stellæ* occurs along with very brilliant and perfect crystals of *rutile* on a soft,

semi-steatitic kyanite at Crowder's mountain in North Carolina; from which region I also possess large masses of deep blue *lazulite* associated in some instances with *topaz;* the latter in distinct crystals.

Brookite occurs in the gold washings of Rutherford county, N. C. Mr. Clingman has supplied me with nearly one hundred crystals, among which I find the following new forms. The angles appended are only approximations.

P on *o* 116° 20′. P on *x* (a plane on the edge P : *l*) 151°. P on M 90°. M on M 100° 45′. M on *l* 140° 30′. M on *o* 151° 40′. *o* on *o* 126° ? *o* on *o′* 78° 0′. *o* on *x* 140° ? *a* on *a* 137° 30′ ?



Monazite.—Crystals of this substance are also abundant in the same situations. They closely resemble the same species from the Urals.

Wavellite.—This mineral has been sent to me by Dr. Pendleton of Athens, Ga. It occurs on a jaspery opal in Washington county near Saundersville, Georgia.

Babingtonite at Athol, Mass. This mineral has been brought to light in the railroad excavations in this town during the past year, in very splendid crystals, associated with epidote, apophyllite, &c.

New Haven, June 20, 1849.

6. *On the existence of Mercury in the Tyrol;* by M. H. Rose, (L'Institut, Fevrier 21, 1849; Lond., E. and D. Phil. Mag., April, 1849.)—M. Weidenbusch, in analyzing in the author's laboratory a specimen of tender gray copper ore, stated to be from Schwarz in the Tyrol, found it to contain a notable quantity of mercury, amounting to 15·5 per cent. This gray copper is mixed with quartz and sulphuret of copper. Its powder is almost black, and has a specific gravity of 5·1075; when heated in a flask, it yields a little metallic mercury with a light reddish-brown sublimate. If it be mixed with carbonate of soda and heated, a large quantity of mercury is obtained. It contains also zinc, iron, antimony and sulphur, and traces of arsenic and silver. These substances exist in it in the same proportions as in other gray copper ores. A crystallized gray copper, also stated to be from Schwarz in the Tyrol, did not contain any mercury.

7. *Mud of the Nile.*—The following analysis of the mud of the Nile, by M. Lassaigne (Journ. de Pharm., t. v, p. 468), is more recent and complete than that given by Lieut. Newbold from Regnault.

Silica,	42·50
Alumina,	24·25
Magnesia,	1·05
Peroxyd of iron,	13·65
Carbonate of lime,	3·85
Carbonate of magnesia,	1·20
Humic acid,	2·80
Water,	10·70
	100·00

III. Zoology.

1. *Conspectus Crustaceorum quæ in Orbis Terrarum Circumnavigatione, Carolo Wilkes e Classe Reipublicæ Fœderatæ Duce, lexit et descripsit* Jacobus D. Dana—(Proceedings of the American Academy of Arts and Sciences, Boston, May 4, 1847, vol. i, p. 150–154, and Nov. 8, 1849, vol. ii, pp. 9–61.)—This Conspectus includes descriptions of 183 new species of Entomostraca, collected by Mr. James D. Dana during the cruise of the Exploring Expedition. We here cite the descriptions of the genera and families introduced, as they contain some modifications of those received, and mention only the names of the new species included in the Conspectus under each genus. As elsewhere stated, the full Report on the Crustacea of the Expedition is in course of preparation and will be illustrated by drawings of these and the other new species collected.

Ordo 2. ENTOMOSTRACA.

Subordo 1. GNATHOSTOMATA.*

Tribus I.—CRUSTACEA CYCLOPACEA (vel Copepoda).†

Familia I. Cyclopidæ.

Oculi duo simplices tantum. *Palpi* mandibularum maxillarumque breves aut obsoleti. *Sacculi ovigeri* duo.

Genus I. Cyclops.—*Antennæ maris anticæ* subcheliformes aut articulo geniculante instructæ.

Sp. C. brasiliensis, curticaudus, pubescens, MacLeayi, vitiensis.

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* See this Journal, 2nd Ser., i, 225.

† Cyclopaceorum membra sunt:—

Cephalothorax 4–7-articulatus. *Abdomen* 1–6-articulatum, carapace non tectum.

Frons sæpissimè rostrata, rostro aut simplice, aut furcato, aut transversim emarginato, aut appendicibus instructo.

Oculi duo simplices, pigmento aut connati aut disjuncti; quoque in quibusdam oculi duo coaliti sub capite insistentes; aliis, oculi maximo lenticulo prolato et corneâ latè oblatâ constructi.

Antennæ anticæ 4–28-articulatæ, aut simplices, aut appendiculatæ; *posticæ* 2–5-articulatæ et sæpe ramum ferentes, aliis ad apicem setigeræ, aliis subcheliformes.

Mandibulæ ad apicem dentatæ, sæpius palpigeræ:—membra cephalothoracis ad normam quarta; itaque breviter denominata ct. iv.

Maxillæ duæ (ct. v.) setosæ; sæpe palpigeræ, palpo sive parvulo et vix discernendo, sive setas diffusas ferente.

Maxillipedes (vel Maxillæ, ct. vi.) duo, aliis parvi et parcius setigeri, aliis crassiores et valde setigeri.

Pedes antici (ct. vii) duo simplices, aut obsolescentes aut elongati, aliis setigeri, aliis subcheliformes.

Pedes biremes decem (ct. viii, ix, x, xi, xii); octo anteriores sæpius natatorii, sed duo antici interdum subprehensiles; duo posteriores plurimum obsoleti aut parvuli; in quibusdam masculinis pergrandes et uno ambove prehensiles.

Abdominis ad basin pertinentes sæpissimè *pedes spurii*, sive obsolescentes sive oblongi et setis armati; ad extremum, styli caudales duo, unusquisque 4–6 setis plerumque plumosis instructus.

Cephalothorace *septem*-articulato, ad segmentum primum antennæ quatuor pertinent; ad secundum, mandibula, maxillæ, et maxillipedes (ct. iv, v, vi); ad tertium,

Familia II. Harpactidæ.

Oculi duo simplices tantum. *Palpi* mandibulorum maxillarumque parvuli, aut obsoleti, setis diffusis non instructi. *Sacculus ovigerus* unicus. *Antennæ posticæ* setis habitu digitorum ad apicem instructæ.

Genus I.—Harpacticus. (*Milne Edwards.*)—*Frons* subrostrata, appendicibus nullis. *Antennæ anticæ maris* subcheliformes, aut articulo geniculante instructæ; *feminæ* basi 2–5 articulatâ et quasi flagello curto sæpius minutè 5-articulato compositæ, ad apicem basis appendicem brevem ferentes. *Cephalothorax* 4-articulatus. *Pedes antici* subcheliformes mediocres.

Syn.—Arpacticus, et Cyclopsina partim (C. castor excluso), *M. Edwards.*—Nauplius, *Philippi.*—Canthocarpus, *Westwood.*—Doris, *Koch.*—Canthocarpus et Arpacticus, non Cyclopsina, *Baird.*

Sp. H. virescens, concinnus, sacer, linearis, roseus, acutifrons.

Genus II. Clytemnestra. (*Dana.*)—*Frons* subrostrata, appendicibus nullis. *Antennæ anticæ* flexiles; *maris*, non subcheliformes. *Pedes antici* (ct. vii,) permagni, subcheliformes.

Obs. Non *Arpacticus* Bairdii: *Cyclops chelifer* Arpacticis pertinet. Magnitudo pedium anticorum character genericum non bene validum, nisi pedes pergrandes, quoque pro antennis geniculatis in coitu usitati sunt; ideoque est antennæ *maris* Clytemnestræ non subcheliformes.

Sp. C. scutellata.

Genus III. Setella. (*Dana.*)—*Corpus* angustissimum fere lineare, anticè attenuatum et subacutum, et fronte appendices duas parvulas falciformes subtus gerens. *Antennæ anticæ* flexiles, appendice brevi instructæ, setis brevibus; *maris* non subcheliformes. *Pedes antici* (ct. vii) mediocres aut parvi. *Pedes proximè sequentes* lateraliter porrecti, ad apicem breviter setigeri. *Pedes abdominis* elongati et longè setigeri. *Setæ caudales* duæ longissimæ, (in speciebus scrutatis corpore valde longiores, spinulosæ, et strictè appressæ,) reliquæ brevissimæ. (Tubum cibarium sæpius lætè rubrum.)

Sp. S. tenuicornis, longicauda, gracilis, crassicornis, aciculus.

Familia III. Calanidæ.

Oculi simplices; etiam sæpe alii duo inferiores deorsum spectantes. *Pedes mandibulares maxillaresque* articulati et longè setigeri. *Sacculus oviger* unicus. *Antennæ anticæ* elongatæ, non appendiculatæ. *Antennæ posticæ* ad apicem setigeræ.

Genera notis sequentibus distinguenda:—

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pedes quatuor antici (ct. vii, viii); (cephalo-thorace *quadri*-articulato, hæc tota adhuc enumerata ad segmentum anticum pertinent;) ad segmenta sequentia, singulatim, duo pedes biremes, (ct. ix, x, xi, xii).

Mandibula est articulus pedis mandibularis primus, et "palpus" articuli sequentes pedis reliqui.

Setæ antennarum plerumque valent ad species distinguendum, et præcipuè illæ articulorum ultimorum. Articulos 2, 3, aut 4, ultimum præcedentes, *subultimos* sæpe vocamus; et eorum setæ, *anteriores* et *posteriores*, scrutandæ et comparandæ.

- Oculis inferioribus nullis.
  - Antennis anticis nec angulo flexis nec articulatione geniculatis.
    - Pedibus posticis (ct. xii.) non prehensilibus, sæpe obsoletis.
      - Pedibus anticis (ct. vii.) majoribus quam maxillipedes (ct. vi.), lateraliter porrectis, non geniculatis. ..... 1. Calanus.
      - Pedibus anticis minoribus quam maxillipedes; maxillipedibus sub corpore geniculatis; abdomine longissimo. ..... 2. Scribella.
    - Pedibus posticis elongatis, subulatis, uno subprehensili; pedibus anticis duplo geniculatis, sub corpore gestis, ad apicem deflexis. ..... 3. Euchæta.
  - Antennis anticis angulo levissimè flexis, nunquam articulatione geniculatis; pedibus posticis *maris* prehensilibus. ..... 4. Undina.
  - Antennâ *maris* anticâ dextrâ geniculante.
    - Maxillipedibus duplo geniculatis, inflexis, setis longis, nudis. ..... 5. Candace.
    - Max. rectis, setis longis, setulosis. ..... 6. Cyclopsina.

Oculis superioribus nullis, inferioribus grandibus; antennâ *maris* anticâ dextrâ geniculante; aliis *Calano* affinibus. ..... 7. Catopia.

- Oculis inferioribus et superioribus.
  - Antennâ *maris* anticâ dextrâ non geniculante, ambabus flexilibus, setis diffusis; pedibus posticis parvulis, uniarticulatis. ..... 8. Acartia.
  - Antennâ *maris* anticâ dextrâ geniculante; setis non diffusis; pede postico dextro crasso, prehensili. ..... 9. Pontella.

Genus I. Calanus. (*Leach.*)—*Rostrum* furcatum. *Antennæ anticæ* sive leviter curvatæ sive rectæ, *maris* non geniculantes. *Pedes postici* (ct. xii.) obsolescentes, *maris* non prehensiles. *Pedes antici* (ct. vii.) elongati, latè porrecti, maxillipedibus (ct. vi.) majores, non geniculati. *Oculi inferiores* nulli. Cephalothorax 4–5-articulatus. *Rami antennarum posticarum* subæqui, ramo breviore ad apicem 3 setis instructo, in dorso setigero.*—Hab. in maribus Atlantico et Pacifico.

Syn.—Cyclops, *Müller.*—Calanus, *Leach.*—Cetochilus? *Roussel de Vauzème.*

Sp. C. rotundatus, comptus, nudus, magellanicus, crassus, furcicaudus, arcuicornis, turbinatus, stylifer, curtus, scutellatus, pavo, levis, medius, placidus, recticornis, setuligerus, pellucidus, affinis, flavipes, tenuicornis, sanguineus, mundus, inauritus, simplicicaudus, appressus, communis, amænus, bellus, gracilis, elongatus, attenuatus, rostrifrons, cornutus.

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* Species optimè distinguendæ sunt:—

1. Per gustum antennarum anticarum; etiam per discrimina setarum, præcipuè apicalium et subapicalium; per longitudinem et numerum articulorum:
2. Per structuram maxillipedium, et pedium anticorum:
3. Per pedes posticos thoracicos:
4. Per numerum segmentorum cephalothoracis, et characteres segmentorum antici posticique:
5. Per stylos caudales et eorum setas:

Articulatio cephalothoracis non character *generica*. Numerus segmentorum abdominis per ætatem variat, et vix valet *species* distinguere.

Genus II. SCRIBELLA. (*Dana.*)—*Antennæ anticæ* elongatæ, pauci-articulatæ, longè setigeræ, setis diffusis, *maris* non geniculantes. *Antennæ posticæ* simplices (?). *Maxillipedes* (ct. vi.) maximi, pedibus proximis majores, 4-articulati, geniculati et prorsum flexi. *Oculi inferiores* nulli. *Cephalothorax* 4–5-articulatus, capite non discreto. *Abdomen* valde elongatum, cephalothorace non brevius. *Styli caudales* oblongi, divaricati. [Sæpius, e basi pedis biremis, seta grandis lateraliter porrecta.]—Hab. in maribus Atlantico et Pacifico.

SYN.—Scribella, *D.*, Amer. Jour. Sci., Ser. 2da, i, 227.

Sp. S. scriba, setiger, abbreviata.

Genus III. EUCHÆTA. (*Philippi.*)—*Frons* acuta. *Rostrum* transversim emarginatum. *Antennæ anticæ* duplo leviter curvatæ, nunquam minimè angulo flexæ, *maris* non geniculantes. *Pedes* maris *postici* (ct. xii.) ambo valde elongati, subulati. *Pedes antici* (ct. vii.) maxillipedibus (ct. vi.) majores, duplo geniculati et sub corpore gesti, penecillum setarum nudarum reflexum ferentes. *Oculi inferiores* nulli. *Cephalothorax* 4–5-articulatus, capite non discreto.—Hab. in maribus Atlantico et Pacifico.

SYN.—Euchæta, *Philippi*, Archiv für Naturgeschichte, vol. ix, p. 55.—Euchirus, *Dana*, Amer. Jour. Sci., Ser. 2da, i, 228.

Sp. E. communis, concinna, pubescens, diadema.

Genus IV. UNDINA. (*Dana.*)—*Antennæ anticæ* ante medium angulo leviter flexæ, ad apicem fronte posteriores, *maris* non geniculantes. *Pedes postici* (ct. xii.) *maris* grandes, dextro subcheliformi. *Pedes antici* (ct. vii.) elongati, maxillipedibus sæpe majores et valde porrecti, non geniculati. *Oculi inferiores* nulli. *Cephalothorax* 4–5-articulatus, capite non discreto.—Hab. in maribus Atlantico et Pacifico.

Sp. U. vulgaris, simplex, inornata.

Genus V. CANDACE. (*Dana.*)—*Frons* quadrata. *Oculi inferiores* obsoleti. *Antennæ anticæ* regulariter et breviter setigeræ, transversæ; dextrâ *maris* articulatione geniculante. *Maxillipedes* (ct. vi.) pedibus proximis majores, duplo geniculantes et inflexi, 4-articulati, setis nudis, longis. *Pedes maris postici* dispares, dextro prehensili. *Abdomen* mediocre. *Styli caudales* breves, setis strictè appressis. [Animal sæpius partim nigrescens.]—Hab. in maribus Atlantico et Pacifico.

SYN.—Candace, *D.*, Amer. Jour. Sci., Ser. 2da, i, 228. 1846.

Sp. C. ornata, pachydactyla, ethiopica, curta, acuta, truncata.

Genus VI. CYCLOPSINA. (*Milne Edwards.*)—*Rostrum* furcatum. *Antennæ anticæ* sive rectæ sive leviter curvatæ, *maris* dextrâ articulatione geniculante. *Maxillipedes* (ct. vi.) pedibus proximis majores, non geniculati, setis longis spinulosis instructi. *Oculi inferiores* nulli. *Cephalothorax* 4–7-articulatus, capite sæpe discreto. *Antennæ posticæ* iisdem *Calani* similes. *Pes maris posticus dexter* grandis et prehensilis. [Maxillipedes, et antennam *maris* anticam pedemque posticum dextrum, *Pontellæ* affinis; antennam posticam, oculos, et habitum, *Calano* similis. *Si oculi inferiores* adsunt, species *Pontellæ* pertinent.]—Hab. in maribus Atlantico et Pacifico.

SYN.—Cyclopsina (C. castor), *Milne Edwards.*—Cetochilus? *Roussel de Vauzème.*—Monoculus (M. castor), *Jurine.*—Cyclops (C. castor), *Desmarest.*—Dioptomus (D. castor), *Westwood.*—Non Cyclopsina *Bairdii.*

Sp. C. longicornis, calanina, tenuicornis, gracilis.

Genus VII. Catopia. (*Dana.*)—Antennæ posticæ et antennarum habitum anticarum *Calano* affinis. Antennam *maris* anticam dextram *Pontellæ* affinis. *Oculi* superiores nulli; oculus inferior unicus (?)—Hab. in mari Sinensi.

Sp. C. furcata.

Genus VIII. Acartia. (*Dana.*)—*Antennæ anticæ* rectiusculæ, flexiles, setis irregulariter diffusis, dextrâ *maris* non geniculante. *Maxillipedes* (ct. vi.) pedibus proximis majores, recti, setis setulosis longis instructi. *Pedes postici* (ct. xii.) parvuli, uni-articulati, 2 setas divaricatas gerentes. *Oculi* duo inferiores et duo superiores. *Setæ caudales* mediocres.—Hab. in maribus Atlantico et Pacifico.

Sp. A. limpida, negligens, tonsa, laxa.

Genus IX. Pontella.—*Rostrum* furcatum. *Oculi* duo *superiores*, pigmentis sive coalitis sive remotis; duo *inferiores* coaliti. *Antennæ anticæ* multiarticulatæ, setis non diffusis, antennâ dextrâ *maris* geniculante. *Cephalothorax* 4–7-articulatus, segmento cephalico sæpe discreto. *Maxillipedes* (ct. vi.) grandes, recti, setis longis, setulosis. *Pedes antici* (ct. vii.) minores. *Pes maris posticus* (ct. xii.) *dexter* crassus, prehensilis.—Hab. in maribus Atlantico et Pacifico.

Syn.—Pontia, *Milne Edwards.**—Irenæus, *Goodsir.*—Broteas, *Lovén.*

Sp. P. elliptica, brachiata, plumata, turgida, curta, contracta, media, crispata, detruncata, simplex, exigua, agilis, acutifrons, acuta, rubescens, emerita, regalis, perspicax, strenua, protensa, hebes, frivola, detonsa, argentea, speciosa, princeps, fera.

Familia IV. Corycæidæ.

Oculi duo grandes plus minusve remoti, lenticulis duobus prolatis maximis, et corneis oblatis instar conspicillorum, constructi; quoque duo oculi connati minutissimi. *Antennæ anticæ* pauci-articulatæ, simplicissimæ. *Antennæ posticæ* simplicissimæ. *Pedes mandibulares maxillaresque* brevissimi. *Sacculi ovigeri* duo.

Genus I. Corycæus. (*Dana.*)—*Corpus* crassum, anticè rotundatum. *Conspicilla* fronte affixa. *Antennæ posticæ* pedibus anticis majores. *Pedes antici* sexu vix dissimiles digito subuncinato tenuique confecti. *Abdomen* pauci-articulatum, appendicibus basis nullis, stylis caudæ styliformibus.—Hab. in maribus Atlantico et Pacifico.

Syn.—Coryceus, *D.*, Proc. Acad. Nat. Sci. Philad., 1847; Am. Jour. Science, Ser. 2da, i, 228.

Sp. C. gracilis, decurtatus, deplumatus, varius, longistylis, obtusus, crassiusculus, laticeps, vitreus, agilis, orientalis, lautus, speciosus, remiger, latus, venustus, pellucidus, concinnus, productus, longicaudatus.

Genus II. Antaria. (*Dana.*)—*Corpus* crassum, antice rotundatum. *Conspicilla* fronte affixa. *Antennæ posticæ* parvæ, ad apicem breviter setigeræ, pedibus anticis (ct. vii.) non majores, carpo posticè angulato. *Pedes antici* sexu vix dissimiles (?), digito tenui subuncinato. *Abdomen* pauci-articulatum. [Cephalothorax postice obtusus.]—Hab. in maribus Atlantico et Sinensi.

Sp. A. crassimana, gracilis, obtusa.

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* *Pontia* Papilionum generis vocabulum, itaque *Pontella* nobis scripsa.

Genus III. Copilia. (*Dana.*)—*Corpus* depressum, fronte latè quadratum, et conspicilla ad angulos anticos gerens. *Antennæ posticæ* digitiformes, digito elongato, subulato. *Abdomen* pauci-articulatum, appendicibus ad basin nullis.—Hab. in mari Pacifico.

Sp. C. mirabilis, quadrata.

Genus IV. Sapphirina. (*Thomson.*)—*Corpus* depressum. *Sexus* antennas posticas stylosque caudales similes, et abdomen pedesque anticos (ct. vii., *vere* maxillipedes,) dissimiles. *Antennæ posticæ* pediformes, digito tenui, 2-articulato, ad apicem unguiculato. *Abdomen feminæ* 5–6-articulatum, thorace subito angustius, appendices breves ad basin latere gerens; *maris* 4–5-articulatum, thorace subito non angustius, appendicibus nullis. *Pedes maris antici* digitum elongati, *feminæ* breves. *Styli* caudales laminati.—*Mares* sæpe lætè opalini aut fulgidè metallini, interdum cærulei. *Feminæ* sæpius incoloratæ, plus minusve pellucidæ; interdum opacæ et azuleæ.—Hab. in maribus Atlantico et Pacifico.

Sp. S. iris, angusta, elongata, metallina, coruscans, inæqualis, ovata, splendens, ovalis, detonsa, indigotica, orientalis, ovato-lanceolata, gemma, bella, opalina, versicolor, tenella, obesa, obtusa.

Familia V. Miracidæ.

Oculi duo conspicillis maximis constructi. *Antennæ posticæ* ad apicem setigeræ. *Pedes mandibulares maxillaresque* brevissimi. *Abdomen* feminæ (an *maris ?*) 6-articulatum. *Sacculus ovigerus* unicus.

Genus Miracia. (*Dana.*)—*Corpus* elongatum, non depressum, ad frontem duas appendices falciformes subtus gerens. *Antennæ anticæ* appendiculatæ, flexiles et non geniculantes. *Pedes antici* (ct. vii.) mediocres, uni-unguiculati; *pedes* duo sequentes biremes, lateraliter porrecti. *Pedes abdominis* longè setigeri. *Setæ caudales* elongatæ.—*Setellæ* affinis, sed conspicilla oculorum diversæ.—Hab. in maribus Atlantico et Pacifico.

Sp. M. efferata, gracilis.

Tribus II. DAPHNIACEA (vel Cladocera).

Corpus testâ plerumque tectum, capite antennisque posticis sæpius exclusis. *Pedes* plures natatorii. *Antennæ anticæ* sæpe obsoletæ, raro elongatæ. *Oculus* compositus. [Membra tota cephalothoracis mandibularia, maxillaria, pediformiaque, numero 12–16.]

Familiæ sunt:—

1. Penilidæ.—Pedes duodecim. Antennæ anticæ obsolescentes.
2. Daphnidæ.—Pedes decem. Antennæ anticæ sive obsoletæ sive uni-articulatæ.
3. Bosminidæ.—Pedes decem. Antennæ anticæ elongatæ, multi-articulatæ.
4. Polyphemidæ.—Pedes octo. Antennæ anticæ obsolescentes.

Familia I. Penilidæ.

Genus Penilia. (*D.*)—*Caput* discretum, longè rostratum. *Antennæ posticæ* grandes, ramis duobus 2-articulatis. *Abdomen* non inflexum, stylis duobus corneis confectum.—Hab. in maribus prope oras.

Sp. P. avirostris, orientalis.

Familia II. Daphnidæ.

Genus I. Daphnia.—*Abdomen* inflexum. *Antennæ anticæ* obsolescentes. *Antennæ posticæ* birameæ, ramis 3–4-articulatis. *Intestina* non convoluta.—Hab. in stagnis.

Sp. D. textilis, australiensis, macrura.

Genus II. Sida.—*Abdomen* rectum. *Antennæ anticæ* fere obsoletæ. *Antennæ posticæ* birameæ, uno ramorum 2-articulato. *Intestina* non convoluta.—Hab. in stagnis.

Sp. S. angusta.

Genus III. Lynceus.—*Abdomen* inflexum. *Intestina* convoluta. *Antennæ anticæ* fere obsoletæ. *Antennæ posticæ* parvæ.

Sp. L. latifrons.

Familia IV. Polyphemidæ.

Pedes octo. Oculus maximus.

Genus Polyphemus.—*Caput* discretum magnum. *Antennæ* birameæ, validæ.—Hab. in mari.

Sp. P. brevicaudis.

Tribus III. CYPRIDACEA (vel Ostracoda).

Corpus testâ bivalvi omnino tectum, posticè incurvatum, capite antennisque nunquam exclusis. *Pedes* nulli biremes nec natatorii. *Oculi* vel simplices vel compositi. *Antennæ* quatuor. [Membra cephalothoracis mandibularia, maxillaria, pediformiaque numero decem.]

Genus I. Cypris. (*Müller.*)—*Testa* integra ad frontem nec perforata nec incisa. *Oculus* unicus. *Antennæ anticæ* setigeræ, subnatatoriæ. *Antennæ posticæ* subpediformes, setigeræ. *Pedes mandibulares* 3–5-articulati. *Maxillæ* quatuor, breves. *Pedes* quatuor, duo uncinis longè confecti, duo sequentes graciles, 4–5-articulati, ad ova pertinentes.—Hab. in stagnis.

Sp. C. speciosa, albida, chilensis, pubescens, vitiensis.

Genus II. Cypridina. (*Milne Edwards.*)—*Testa* breviter rostrata corpus omnino tegens, et clausa. *Oculi* duo compositi, remoti. *Antennæ anticæ* setis paucis inæquis ad apicem instructæ, setis rectis, sæpe divaricantibus, vix natatoriis. *Antennæ posticæ* 5–7 articulis brevissimis longè et plumosè setigeris confectæ. *Pedes mandibulares* 5-articulati, digitiformes, apicem unguiculati. *Maxillæ* sex, breves, breviter setigeræ, paris secundi laminam ciliatam ad basin gerentes, setis longis, plumosis. *Pedes* duo, longissimè vermiformes, omnino flexiles, ad ova pertinentes, ad apicem setis spinulosis partim reversis armati. *Abdomen* spinulis biseriatis confectum.—Hab. in maribus Pacifico et Atlantico.

Sp. C. luteola, punctata, olivacea, gibbosa, formosa.

Syn. Asterope, *Philippi.*

Genus III. Conchæcia. (*Dana.*)—*Testa* interdum breviter rostrata, corpus omnino tegens, fronte apertâ. *Oculi* simplices. *Antennæ anticæ* 3–4-articulatæ, apicem longè setigeræ. *Spiculum* inter antennas sarcosum, simplex, exsertile. *Antennæ posticæ* 5–7-articulatæ, articulis brevissimis longè setigeris confectæ, ramo altero brevi. *Pedes man-*

dibulares fermè 5-articulati, non unguiculati, apice articuli primi interno et sæpius basi secundi interno simul corneis (instar mandibulæ) et denticulatis. *Maxillæ* quatuor. *Pedes* quatuor, tenues. *Abdomen* spinulis biseriatis confectum.—Hab. in maribus Pacifico et Atlantico.

Sp. C. agilis, rostrata, brevirostris, inflata.

Subordo 2. CORMOSTOMATA.

Os rostriformis.—Tribus quatuor sequentes :—

I. Monstrillacea.—Corpus elongatum (Cyclopiforme). Maxillæ pedesque antici obsoleti. Pedes postici octo natatorii.

II. Caligacea.—Corpus sæpius depressum. Maxillæ pedesque toti numero 12–14, octo pedes ultimi plerumque natatorii, plurimi testâ tecti.

III. Lernæacea.—Corpus depressum aut vermiforme. Antennæ pedesque partim obsoleti.

IV. Nymphacea.—Corpus breve, araneiforme, abdomine obsolescente.

Tribus I. MONSTRILLACEA.

Genus Monstrilla. (*Dana.*)—*Cephalothorax* fere cylindricus, 4-articulatus. *Abdomen* 5-6-articulatum. *Antennæ* duæ. *Oculi* duo simplices ; quoque oculus inferior sicut *Pontellis*. *Truncus buccalis* parvulus subconicus, maxillis pedibusve non munitus. *Pedes* octo, natatorii.—Hab. in mari "Sulu."

Sp. M. viridis.

Tribus II. CALIGACEA.

Familiæ quinque sequentes :—

1. Argulidæ.—Corpus anticè latè peltatum. Ovarium externum nullum. Pedes antici largè tubulati, suctatorii.

2. Caligidæ.—Corpus anticè latè peltatum. Ovarium externum tubiforme, rectum, ovis uniseriatis. Pedes quatuor antici subprehensiles. Antennæ posticæ carapace tectæ.

3. Dichelestidæ.—Corpus depressum, valde angustum. Antennæ posticæ carapace non tectæ. Ovarium externum tubiforme, ovis uniseriatis.

4. Ergasilidæ.—*Corycæis* affines. Corpus vix depressum, plus minusve Cyclopiforme. Antennæ posticæ carapace non tectæ. Ovarium externum elongatum aut sacculiforme, ovis non uniseriatis.

5. Nicothoidæ.—Corpus plerumque Cyclopiforme, sed e lateribus longissimè alatum. Ovarium externum sacculiforme, ovis non uniseriatis.

Familia II. Caligidæ.

Subfamiliæ Caligidarum nobis sunt :—

1. Caliginæ.—Truncus buccalis subovatus, obtusus. *Maxillæ* trunco buccali remotiusculæ, posticè aculeo-elongatæ. *Tubum* ovigerum externum rectum. Corpus anticè latius. (Genera sunt *Caligus*, *Lepeophtheirus*, *Chalimus*, *Caligeria*, *Calistes*.)

2. Pandarinæ.—Truncus buccalis tenuis acuminatus. Maxillæ ad truncum buccalem appressæ, parvulæ, lamellatæ. Tubum ovigerum externum rectum. Corpus posticè interdum latius. (Genera sunt *Pandarus*, *Trebius*, *Nogagus*, *Specilligus*, *Dinematura*, *Phyllophora*, *Euryphora*, *Lepidopus*.)

3. Cecropinæ.—Truncus buccalis tenuis, acuminatus. Maxillæ ad truncum buccalem appressæ. Tubum ovigerum externum sub testam convolutum. Corpus posticè latius. (Genera sunt *Cecrops*, *Læmargus*.)

Caligaceorum segmenta corporis auctoribus sæpe malè data. Segmentum *abdominis* anticum, ovarium externum gestans, *thoracis* posticum sæpe vocatum.* In Cyclopaceis Caligaceisque ovarium externum ad segmentum secundum abdominis *normalem* semper pertinet. His animalibus et Cyclopaceis Crustaceisque aliis comparatis, affinitates veræ educentur. Tabula sequens, membris ordine enumeratis, hæc comparationem exhibet.

Segmenta.	Astacus.	Lucifer.	Cyclops.	Pontella	Caligus.	Penilia.	Daphnia.	Cypris.
1. *Cephalothoracis.*								
I.	Oculi	Oculi	00	00	00	00	00	00
II.	Ant. I.	Ant. I.	Ant. I.	Ant. I.	Ant. I.	Ant. I.	00	Ant. I.
III.	Ant. II.	Ant. II.	Ant. II.	Ant. II.	Ant. II.	Ant. II.	Ant. II.	Ant. II.
IV.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.
V.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.
VI.	Max.	Max.	Maxd.	Maxd.	P. verg.	P. nat.	P. nat.	Maxd.
VII.	Maxd.	Maxd.	P. preh.	P. preh.	P. preh.	P. nat.	P. nat.	P. verg.
VIII.	Maxd.	Maxd.	P. nat.	P. nat.	P. nat.	P. nat.	P. nat.	P. ovar.
IX.	Maxd.	P. subnat.	P. nat.	P. nat.	P. nat.	P. nat.	P. nat.	00
X.	P. chel.	P subnat.	P. nat.	P. nat.	P. nat.	P. nat.	P. nat.	00
XI.	P. verg.	P. subnat.	P. nat.	P. nat.	P. nat.	P. nat.	00	00
XII.	P. verg.	P. subnat.	0 vel 00	P. genit.	00	00	00	00
XIII.	P. verg.	0	00	00	00	00	00	00
XIV.	P. verg.	0	00	00	00	00	00	00
2. *Abdominis.*								
I.	P. rud.	P. rud.	0 vel P. rud.	0 vel 00	0 vel 00	P. rud.	0 vel P. rud.	0 vel 00
II.	P. rud.	P. rud.	0	0	0	0	0	0
III.	P. rud.	P. rud.	0	0	0	0	0	0
IV.	P. rud.	P. rud.	0	0	0	0	0	0
V.	P. rud.	P. rud.	0	0	0	0	0	0
VI.	Ap. caud.	Ap. caud.	Ap. caud.	Ap. caud.	Ap. caud.	Ap. caud.	Ap. caud.	Ap. caud.
VII.	0	0	00	00	00	00	00	00

In hâc tabulâ abbreviationes sequentes:—

Ant.	Antennæ.	*P.*	Pedes.	*Preh.*	Prehensiles.
Ap.	Appendices.	*Chel.*	Cheliformes.	*Ovar.*	Ovariani *vel* ovarium.
Mand.	Mandibulæ.	*Verg.*	Vergiformes.	*Rud.*	Rudimentarii.
Max.	Maxillæ.	*Nat.*	Natatorii.	*Caud.*	Caudales.
Maxd.	Maxillipedes.	*Subnat.*	Subnatatorii.		

0. Membra segmenti obsoleta.
00. Segmentum ejusque membra simul obsoleta.

Subfamilia 1. Caliginæ.

Genus I. Caligus.—*Cephalothorax* 2-articulatus; segmento antico latè peltato, fronte discis duobus suctatoriis plerumque instructâ; postico parvulo, non alato. *Oculi* simplices pigmento unico conjuncti. *Antennæ posticæ* prehensiles, et extus basin spinâ crassâ sæpius munitæ. *Pedes* duo antici vergiformes, bifidi;† duo proximi sequentes subprehensiles digito acuto confecti; sex sequentes natatorii; duo reliqui simplices, vergiformes. Venter furculâ parvulâ armatus. *Abdomen* 2–3-articulatum, appendicibus caudalibus sublamellatis, marginem setigeris. [Sexus antennas posticas, pedes paris secundi et formam abdominis, valde dissimiles.]

Sp. C. thymni, productus, gracilis, (Lepeophtheirus) bagri.

* Vide "*Hist. Nat. des Crustaces*, par M. Milne Edwards," iii, 445 et seq.

† Extremitas bifida articulo tertio et apice secundi elongato composita.

Genus II. CALISTES. (*Dana.*)—*Caligo* similis. *Cephalothorax* 2-articulatus, segmento postico non alato. *Pedes duo postici* biramei, subnatatorii.

Trebio affinis, sed cephalothorax non 3-articulatus et maxillæ nec lamellares, nec ad truncum buccalem appressæ.

Sp. C. trigonis.

Genus III. CALIGERIA. (*Dana.*)—*Caligo* similis. *Cephalothorax* 2-articulatus, segmento postico bialato. *Pedes duo postici* biramei, setis brevibus, non natatoriis.

Sp. C. bella.

Subfamilia 2. PANDARINÆ.

Genus I. NOGAGUS. (*Leach.*)—*Cephalothorax* 4-articulatus, fronte arcuatâ, segmento secundo ad latera posticè producto, duobus sequentibus non alatis. *Abdomen* stylis brevibus sublamellatis setigerisque confectum. *Oculi* simplices, remotiusculi: (an quoque oculus subtilissimus intermedius?). *Pedes* paris secundi crassè cheliformes; pedes natatorii octo, grandes.

Sp. N. validus.

Genus II. SPECILLIGUS. (*Dana.*)—*Nogago* segmenta cephalothoracis pedesque affinis. *Oculi* duo remotiusculi, et *conspicillis grandibus* instructi, eisque Sapphirinæ similes.

Sp. S. curticaudus.

Genus III. PANDARUS. (*Leach.*)—*Cephalothorax* 4-articulatus, carapace grandi, segmentis sequentibus transversis, secundo ad latera alatè producto, tertio quartoque posticè alatis, et bilobatis. *Abdomen* 2–3-articulatum, segmento ultimo tecto, secundo posticè rotundato et utrinque stylis caudalibus sæpius munito. *Pedes* paris secundi crassè cheliformes; natatorii octo, setis brevissimis. *Oculi* duo, remotiusculi. *Styli caudales* styliformes, acuti, subnudi.

Sp. P. concinnus, satyrus, brevicaudus.

Genus IV. DINEMATURA. (*Latreille.*)—*Cephalothorax* 3-articulatus, segmento secundo parvo, testâ tertii dorsali posticè valde expansâ et profundè bilobatâ, eoque elytroideâ. *Abdomen* 2-articulatum, carapace paulo angustius, oblongum, segmento antico maximo, posticè bilobato, postico parvulo, celato. *Styli caudales* lamellati, terminales.

Sp. D. braccata.

Genus V. LEPIDOPUS. (*Dana.*)—*Corpus* anticè non latius. *Cephalothorax* 3-articulatus, carapace minore quam abdomen, segmentis duobus sequentibus posticè largè bialatis. *Abdomen* 2-articulatum, segmento postico parvulo, celato, antico maximo et posticè bilobato. *Antennæ posticæ* articulo tenui falciformi confectæ. *Pedes paris secundi superficie terminali latâ prehensili squamatâ instructi. Pedes natatorii* quatuor ultimi similes, latè lamellati.

Sp. L. armatus.

Tribus IV. NYMPHACEA.

Genus ASTRIDIUM. (*Dana.*)—*Pycnogono* affinis. *Caput* duobus maxillipedibus subtus instructum parvulis, debilibus, ad apicem obtusis, non prehensilibus. *Pedes* octo unguiculo confecti. *Abdomen* perbreve.

Sp. A. orientale.

IV. Miscellaneous Intelligence.

1. *On Certain Frozen Leaves;* by J. Gorgas, (communicated to the Wilmington Botanical Society and sent for publication to this Journal.)—During the recent cold weather (April 15th and 16th, 1849), the leaves of the Buxus sempervirens, (tall box,) common in cultivation, the flowers having mostly fallen and the fruit beginning to form at the time, exhibited some unusual appearances. The leaves of this plant are of a peculiar structure, and have what may be termed a lining so entirely free from the upper blade, except on the edges, that when the edges, forming the suture, are pared off, the two laminæ fall apart without the use of any mechanical means to separate them. The sutures as well as both blades of the leaf proved upon experiment to be entirely impervious to water. On the mornings of both the days above mentioned, the leaves were found to be very much distended by the presence of some hard substance between the upper and lower blades, and upon paring away the edges of the leaf the blades separated, disclosing a firm piece of clear ice, entirely free from discoloration, of the shape and size of a large seed of the common pumpkin, and in the larger leaves full one-sixteenth of an inch in thickness, swelling them in some instances almost to bursting. Upon an examination at 9 o'clock A. M., these pieces of ice were found to have disappeared from the leaves on the sunny side of the tree, remaining however in those on the shady side. At 12 o'clock, all had disappeared, the leaves having assumed the natural shape without apparent detriment, from having been subjected to an ordeal so unusual and severe; nor was any moisture apparent in the leaves either at this time or on the evening of the first day when a reëxamination was made. The lumps of ice were much larger on the second and colder morning than on the preceding one, and might have burst the leaves had it been still colder. A thermometer hanging in a piazza adjoining the garden in Wilmington, Del., where the tree was situated, indicated at sunrise on the morning of the 15th, 32°, and on that of the 16th, 30°, but the mercury was much lower in some situations in the surrounding country, even as low as 22°, it is said, in some places near Wilmington. After making these statements the author enquires, whence came in a few hours a quantity of liquid sufficient to form in the leaves masses of ice comparatively so large? and how could it so completely disappear again in a few hours more? the leaf being, as he concludes, so firm and compact and the edges of its two laminæ so completely joined as seemingly to preclude the possibility of absorption of the liquid from the atmosphere as well as the evaporation of the melting ice, and he supposes that for some purpose necessary to the well being of the plant, at a time so trying, the sap is rapidly forced into the leaf and there congealed, to be as rapidly withdrawn when melted by a milder atmosphere which renders its presence in the leaf unnecessary. Another member of the society has suggested as an explanation of the facts, that probably this superabundant sap was forced into the leaves by the congelation and consequent expansion of a portion of that in the stem, into which it would of course be reabsorbed as soon as both portions reassumed the liquid state. It has been

further suggested that the regular evaporation of moisture from the leaves was checked by the cold, whilst its supply to them from the plant was continued, and hence the collection of liquid, which, as the ice formed from it was thawed, would be evaporated as usual through the pores of the leaf.

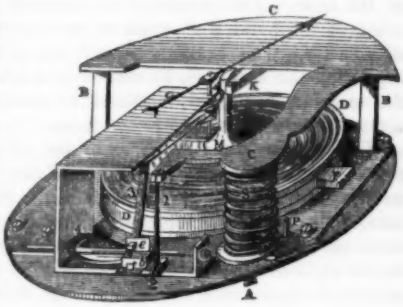
2. *On the Mechanism and Functions of the Organs of Voice in Man; with the introduction of a case of double utterance;* by Dr. PETTIGREW, (Royal Society, Athen., No. 1126.)—After a few prefatory observations upon the pleasure derived from the study of anatomy, more especially when assisted by the labors of the scientific chemist, the natural philosopher and mechanician,—the lecturer entered upon the subject above mentioned; first describing the situation of the larynx and its contiguous parts. Its skeleton was made up of a number of parts; the material chosen for which was gristle, the best vibratory substance found in the frame,—other parts, as the ear, in connexion with sound, being formed of a similar fabric. It consisted of many parts, as it was to be elongated, shortened, widened or narrowed. The gristles were to be held together; this was effected by bands of an inelastic nature, by which means displacement was prevented; the parts were acted upon by groups of muscles (the moving powers of the body); the muscles (as waste took place upon any movement) were well supplied by arterial or nourishing blood, the refuse being returned by the veins into the circulating system again to undergo purification in the lungs. The muscles were put into action by the nerves; these emanating from the brain and upper part of the spinal marrow, and thus under the control of the will. The connexion of these nerves with those of respiration, the heart, lungs, and stomach was described; and an especial ganglion (dissections of which from various animals presented by the late Sir Astley Cooper to the lecturer were exhibited) giving exquisite sensations to the opening to the larynx as an entrance to the lungs was, from its great importance, particularly dwelt upon. A set of vessels, called absorbents, removed the effete materials of the organ. Internally the larynx presented a smooth membrane, having the power of secreting a fluid of a glairey nature for the purpose of preventing injury to the more delicate parts from the passage of the air to the lung cells. At the upper part of the larynx, beneath the mucous membrane, four vocal cords were described, two upon each side; these bounded the cavity of the ventricles leading to the sacculi of the larynx. Upon the action of the vocal bands depended the pitch of voice. All sounds emanating from the larynx were simple, the larynx being with regard to the voice what the reed is to the hautboy or clarionet. Many experiments were shown proving that the primitive sound was produced by the vocal bands forming the edges of the glottis; and the peculiar baa-ing of the lamb was imitated by an apparatus contrived and attached to the larynx and windpipe of a dead lamb. Other points in connexion with the subject were illustrated by numerous specimens upon the table, and a new instrument kindly lent for the occasion by Mr. Wheatstone. The damper in this instrument was particularly described as illustrating the action of certain muscles in the human body upon the thyroid gland; thus presenting the continued vibration of one sound into another,—Sir Charles Bell's theory being revived by the lecturer, and sup-

ported by allusions to comparative anatomy. Attention was drawn to intensity of voice, capacity, and also the tones in the male, female, and boy. Articulation and speech were described as modifications of voice and produced by the action of the pharynx, the nasal cavities, the tongue, and muscles about the cheeks and lips. A child before it had cut its teeth could only utter labial words, such as *papa*, *mama*, *baby*, or in humble life *daddan* instead of *father*, the tongue being then pressed against the palate. Dr. Pettigrew then alluded to the manner in which ventriloquism was performed; which was illustrated by Mr. Brook, who imitated a man in the chimney ascending and descending. Mr. Richmond was then introduced; who performed two airs, each as a duet, synchronously. After a very careful examination, assisted by Dr. Macdonald, Prof. Bowman, and M. Garsin, the lecturer had arrived at the conclusion that the two tones were thus accomplished; the voice was of course simple and produced in the larynx; the current of vibration was split, as proved by the flame of a candle,—the bass notes being modified in the upper part of the pharynx and nasal passages, the treble being produced by the tongue forming with the arched roof of the palate a tube, open by a very small aperture in front, the tube being altered in length by the nicest adjustment of its muscles, these latter acting more perfectly from the fixature to the os hyoides and the roof of the mouth.

3. *The Aneroid Barometer*, (from the Mining Journal, xix, 123.)—This elegant and truly philosophical instrument, which is proposed as a substitute for the Torricellian tube, is the invention of a French gentleman of scientific attainments, named Vidi; and the public are much indebted to Mr. Dent, of the Strand, for the publication of a pamphlet, entitled "A Treatise on the Aneroid Barometer, with a short Historical Notice on Barometers in General—their Construction and Use." The introduction of this new barometer has been entrusted to this eminent chronometer-maker, which alone is a guarantee for the excellence of the principle, and the perfection of the mechanical construction. Mr. Dent commences the work with an historical description of the common barometer, which, although sufficiently common to form a general piece of furniture, is by no means generally understood; from the period when Galileo first discovered the cause of water rising in a pump from the exhaustion by the sucker 32 ft., to be the pressure of the atmosphere, describes the experiments on mercury by his pupil Torricelli in 1643, and the subsequent construction of the common barometer; then proceeds to the wheel and dial barometer, the invention of the late eminent philosopher, Dr. Hooke, which is now the one generally in use, except for marine purposes, and concludes with a description of the sympiesometer, also the invention of Dr. Hooke. This latter kind of barometer consists of two tubes—one containing spirits, the other colored water, and shows not only the atmospheric pressure, but its temperature also. On the subject of a vacuum vessel, to take the place of the mercurial tube for barometrical measurement, we learn that M. Conté, Professor of the Aërostatical School at Meudon, near Paris, was the first to call attention to the subject, as in his balloon ascents, during the war in Egypt, he found the ordinary barometer subject to so much oscillation as to be useless; he,

therefore, constructed an instrument, somewhat in shape of a common watch. It consisted of a bowl of strong iron, or copper, upon which was a domed cover of very thin sheet steel, the edges fitting with great exactness. Springs fixed in the bowl keep the cover at a proper elevation; the air is pumped out, and as the resistance of the springs is uniformly the same, the cover plate rises, or falls, as the atmospheric pressure varies, and these variations are shown by means of a hand, securely fastened, passing backward and forward on a divided plate. M. Conté, however, was compelled to reject the instrument, on account of the prejudicial influence which change of temperature had upon it. It was left to Mr. Vidi's ingenuity to construct an instrument on scientific principles, in which he has been most completely successful, and in which he has adopted most ingenious means for correcting the variations of temperature—viz.: by the introduction of gas into the vacuum vase of the instrument; and, on its capacity being diminished by heat, the gas contained within it is, by the same cause, expanded, and resisting the compressing force of the atmospheric weight upon the diaphragms, keeps them separated at a due distance, and effects the compensation. The Aneroid barometer consists of a vessel of the shape and size of a chronometer—the internal arrangement of which is shown by *fig.* 1. D, D, is the vacuum vase; C, C, a lever, resting on its fulcrum B B, and spiral spring S—to the end of which is attached a vertical rod, 1, which serves to connect the lever C C, with the levers 2 and 3. These are connected by a bow piece, 4; and two square-headed screws, at *e*, *b*, admit, by screwing or unscrewing them, such an alteration of the distance of leverage, as to allow the hand of the Aneroid to move over a space corresponding with the scale of a standard mercurial barometer; to the end of lever, 3, is attached a light rod, terminating with a piece of watch chain, attached to a small roller. On the axis of this roller, the hand is fixed, and kept in its position, by means of a spiral spring—the outer coil of which is seen attached to the axis. M is the socket, which, being pulled by the pin, K, places the vase in a state of tension, whereby it offers resistance to the pressure of the external atmosphere; and the diaphragms are kept

1.



2.

separate after exhaustion, by fixing the pin K, to the lever C. The surface of the top of the vase D, is formed of fine corrugated metal. F is the orifice, where the exhaustion is effected.

To set the hand of the Aneroid to correspond with any other Barometer.—A, the head of the screw, *fig.* 1, to be considered as at the back of the case. This screw, when screwed or unscrewed, alters the position of the hand, and is not to be touched *for any other purpose.* It acts in a piece of brass, seen at P, *fig.* 1, which is prevented from turning round the spring S, by means of a pin inserted in the plate. When the screw A, is turned, it raises, or depresses, the lever C C, whence motion is communicated to the hand.

To Register the Variations of the Aneroid.—A nut, as seen at O, *fig.* 2, projects through the centre of the glass, to enable the observer to move the gilt index, W, beneath it. By this gilt index, the registration of the hand *b*, is effected. The gilt hand being placed over the steel one, should the latter have subsequently deviated from W, either to the right or left, the difference will be the result of increased or diminished atmospheric pressure. *Fig.* 2, is a representation of the outer case, with a Fahrenheit's thermometer attached. In the *Mining Journal*, of Feb. 3, Dr. Murray has borne his testimony to the sound scientific principles on which this instrument is based, and the vast utility it will prove to the seamen, aëronauts, and those engaged in mountain travelling—indeed, to aërostatic science generally.*

4. *Gold at Port Phillip, South shore of Australia*, (Athen., No. 1132.)—Newspapers to the 9th inst. have come to hand from Melbourne. The most important intelligence is the following, which we copy from the *Argus* of the 31st ultimo.—"Port Phillip a Gold Mine!—We hasten to apprise our readers of the important discovery of an extensive gold field in this province, yielding the virgin metal in such quantities as, to all appearance, will throw California into the shade. The particulars of the discovery, as detailed by one of the parties, are as follows:—A shepherd called some weeks since upon Mr. Brentani with a specimen of metal which he had found in his wanderings, and which immediately struck Mr. Brentani as being fine gold. He applied for a more accurate assay to Mr. Duchene, who at once pronounced it a fine specimen of the precious metal. Mr. Duchene proceeded with the shepherd to the spot, in the neighborhood of the Pyrenees, and found indications of the metal in great abundance, and extending over a large space. He returned to Melbourne with ore sufficient to yield 100*l.* worth of pure gold. He describes the gold as being abundant, and the quality as better than any he has hitherto seen worked. The quantity contained in the mine visited by them was incalculable:—indeed, he says there is a tract of territory at least five miles in extent which furnishes everywhere abundant indications of the existence of gold. Mr. Duchene picked up one piece of the metal weighing 2 lb. 3 oz. which contained upwards of 90 per cent. of virgin gold; in fact, it presented the appearance of a lump of molten gold, interspersed with a few quartz pebbles. We have seen it as picked out of the earth; and Mr. Duchene

* We believe that the value of the Aneroid barometer cannot yet be considered as fully established.—Eds.

has kindly left a specimen at the *Argus* office for inspection. It is therefore indubitable that gold has been discovered."—This extraordinary news has produced quite a mania throughout the Port Phillip district, and hundreds are stated to be proceeding to the new El Dorado. Some of the papers disbelieve the whole story; others are equally firm as to the truth. That gold has been found there appears to be beyond doubt,—but the quantity is questionable.

5. *The Tin Mines of Banca*, (Mining Journal, xix, 178.)—The period of the discovery of the tin deposits of Banca is not so remote as is generally imagined. From 1700 to 1720 the first workings commenced, which were then insignificant; but as the prolific nature of the strata became known, the produce rapidly increased. Attracted by the prospect of gain, numerous Chinese miners and adventurers resorted to Banca, and, as one source of ore failed, gradually explored and removed to other districts, spreading successively over the island, and selecting the most favorable spots, where a rich store of ore was in the vicinity of a stream of water, to facilitate their labors. After a lapse of thirty or forty years a gradual diminution of produce was observed in many of the working districts; others were entirely exhausted, and new situations attempted. The most prosperous period of the island, both as regards the supplies of tin obtained, and the general condition of the inhabitants, was during the reign of Sultan Achmád Nádjá Mudin I, or between the years 1750 and 1775: 60,000 piculs, or 120,000 ingots, is but a moderate estimate of the aggregate produce of the mines during this period, and by most persons considered competent to judge, it is supposed to have been much greater. Since the year 1780 a decrease has become more evident, and 30,000 piculs were rarely produced in one year. During the last fifteen years the annual quantity has further decreased: the position of the mines elucidates this in a great degree; the ore is deposited in horizontal beds, at a short distance below the surface, which, in former times, were immensely productive; but the inquisitive shrewdness of the Chinese directing them to the most profitable spots, extensive surfaces may be observed in the western and northern divisions of the island, which have been turned up and drained of their wealth, exhibiting the remains of former mines and aqueducts. The process of mining is very simple; it consists in the formation of a pit or excavation, of a square or oblong form, perforating the ground perpendicularly to the beds containing the tin, which are rarely far below the surface, and in the proper application of a stream of water to facilitate the labor and for washing the ore. When once perforated, the miners continue to dig pits in succession from the same surface until the whole is abandoned, in consequence of the exhaustion of the ore; thus in travelling through the country, surfaces of several square miles are observed, which have been turned up by the process of mining. When a sufficient quantity of ore has accumulated, and been properly washed and dressed, it is subjected to the smelting process, which operation, in favorable seasons, is performed twice a year—in the usual seasons only once, between the months of February and April. It is performed in a spacious open shed, about seventy-five feet long, thirty-five feet broad, and twenty-four feet high in the middle—the upper portion of the roof being separated from the lower by an opening of about two feet, to prevent ignition. The

central portion of the shed contains the furnace, while the ends are the receptacles for the fuel, ore, and various requisites in the process. The furnace is ten feet long, four feet high, and four feet wide; the fireplace occupies the middle portion, descending three feet into the body of the furnace, and beneath is a basin-shaped receptacle, for the refined metal.

The bellows is a large wooden tube, formed out of a single tree, and a piston being worked backward and forward keeps up a continuous stream of air. The sand moulds are placed near the furnace, and when sufficient metal has run, the moulds are filled, sixteen ingots being cast at one time, and generally 44 to 45 in a night's work—the work being carried on at that period of the twenty-four hours, in consequence of the extreme heat of the day. The smelting of the ore, and the preparation of the coals, each requires habit and experience, and are performed by persons who make a regular profession of the business; the smelters are paid by the night, and the coal burners by the basket of coals employed. The facility, however, with which the ore is collected, and the simplicity of the methods of mining, require, as compared with other mining countries, little assistance from machinery; besides, the implements in general use are neither numerous nor difficult to use, and hence few artificers are required at the mines.

6. *Navigation of the Arctic Regions*, (United Service Gazette; Athen., No. 1122.)—Commander Joseph West, an officer of long standing, has proposed a plan of fitting a steam-vessel with ice hammer and ice saws, to be worked by a shaft of the engine, for the purpose of navigating the polar regions. The projection is applicable to either screw or paddle-wheel steamers, and is thus explained:—A semicircular cogged plate is fixed on the shaft, which connects itself with an elevating bar, fixed to the end of a sway beam, the fulcrum being in a crank on the bow of the vessel, at the fore end of the sway beam, where the ice hammer is hung, which by the connection of the cogs, is raised eight feet at every revolution. It is thrown out of gear when they disconnect, the hammer then falls, and is again raised when the cogs connect. The hammers are from fifteen to twenty hundred weight, working alternately on each side before the stem, and are capable of breaking through ice four or five feet thick; thus enabling a vessel so fitted to approximate much nearer to the supposed position of Sir John Franklin's ships than can be done by the present means,—as the above application can be fitted to any steam vessel at a trifling expense compared with the object to be obtained. The invention is simple as it appears to us to be practicable; and we trust that the Admiralty will appreciate the value of the plan, and the motives which actuated the gallant projector, by despatching a vessel so fitted at once on the perilous track of the almost despaired-of northern navigators.

7. *Type Manufacture*, (Athen., No. 1127.)—The Earl of Rosse gave his third Soirée as President of the Royal Society on Saturday last. There were several models and inventions exhibited:—the most remarkable amongst the latter being a machine for manufacturing printing types without fusing the metal and pouring it into moulds. The inventor, M. Petit, effects his process by the use of steel dies and matrices which by means of powerful pressure impress the letters, &c. on copper fashioned into quadrangular strips of indefinite length wound

round a cylinder. The hardness of ordinary copper over type metal is in the proportion of 100 to 1. A London firm employed to print stamps for the Government is in the habit of using raised copper surfaces for the purpose:—no less than 125,000,000 impressions have been taken from one of their plates. The density of the copper used in the manufacture of type is considerably increased by the compression which it undergoes by the machinery of M. Petit. The machine produces thirty-two types per minute; and it would be difficult to exceed the typographic neatness of the character. Specimens of the type and printing were distributed among those present.

8. *New Mode of copying Engravings;* by M. Niepce, (ibid.)—An engraving is placed in a box containing iodine at such a temperature that a small portion is vaporized. The ink of the engraving condenses a much greater proportion of the vapor than the mere blank paper; so that when after a few minutes the engraving is taken out, exposed a moment or two to the air, and then laid on a film or two of *starch*, part of the iodine becomes detached from the engraving, and is transferred to the film of starch, producing a very delicate and beautiful copy of the engraving. As may be supposed, there are many niceties required which M. Niepce only can practice with perfection. It is necessary to inclose the film of starch between two glass plates in order to preserve it.

9. *Herbaria of New England Plants.*—The extensive collections of New England Plants, made by the late Wm. Oakes, Esq., have been distributed into sets, and the specimens named with printed labels. These are now offered for sale for the benefit of his family. The labor of a life and large pecuniary sums have been expended in the formation of these collections, which were designed to illustrate and form a basis of an elaborate Flora of New England. The numerous botanists, to whom the lamented Mr. Oakes generously imparted his specimens during his life time, do not need to be told that they are remarkable for their perfection and beauty. The specimens now distributed fully sustain this character, and they are for the most part very copiously supplied to the sets. Nearly one-half the number, of which the fullest sets comprise six hundred species or varieties, are alpine or subalpine plants of the White Mountain region, which Mr. Oakes has so sedulously explored for many years; and among the rest will be found most of the rarer plants of New England, such as are in the hands of few botanists. They consist entirely of Phænogamous plants, and Ferns; the Musci, Hepaticæ and Lichens, if not otherwise disposed of, will be hereafter distributed.

It is thought that literary institutions as well as botanists would be glad to obtain such a New England herbarium, one which can only be formed at an expense of time, labor, and indefatigable research, which probably will never be again devoted to this object. It is not expected that the actual cost of preparing these collections will be reimbursed by their sale. But, to secure immediate though inadequate returns, they are offered at an extremely low price; namely, the sets that contain 570 to 600 species or varieties, at twenty-four dollars, those of about 550 plants at twenty-two dollars; those of 500, at twenty dollars. Application may be made (post paid) to Charles R. Thayer, Merchant, of Boston, or to Professor A. Gray of Harvard University, Cambridge.

A. Gr.

10. *British Museum*, (Athen., No. 1130.)—The total amount expended on the new building and fittings of the British Museum, and for ornamental sculpture, from the commencement of the re-building in 1823 up to the 31st of March, 1849, amounts, as shown by a Parliamentary return, to 696,995*l*. The total amount of expenditure that will be required for further buildings and fittings is estimated at 56,500*l*.

11. *Platinum and Diamonds in California.*—The existence of Platinum in the gold sands of California has of late been often announced. Specimens from the region have recently been seen by the editors of this Journal.—We also learn from a reliable source that the diamond occurs at the placers. The writer—Rev. Mr. Lyman—describes a crystal seen by him, of a straw-yellow color, having the usual convex faces, and about the size of a small pea. He saw the crystal but for a few moments, and had no opportunity for close examination: but the appearance and form left little doubt that it was a true diamond.

12. *W. Lassell.*—The Royal Society of London has presented to Mr. Lassell a medal for the discovery of the planet Metis, of one at least of the Satellites of Herschel, of a Satellite of Neptune, and of an eighth Satellite of Saturn.

OBITUARY.

13. George W. Whistler.—We had hardly received the announcement of the decease of our old friend, commemorated in the last number of this Journal;—ere we were called to grieve for the loss of another; who, a man of science applied in a different walk, has been the means of extending in another hemisphere the reputation of not only his own but of the American name. We sorrowfully pay the due tribute to worth like his, thus cut off in the midst of usefulness and before attaining the zenith of fame to which he might justly have looked, by furnishing the following notice of the principal epochs of his life and works; prepared by one, who at an earlier period served with and under him.

George Washington Whistler was born in May, 1800, at Fort Wayne in the present State of Indiana, but then part of the Northwest Territory. This post was commanded by his father, Major Whistler; then and till after the war of 1812, an officer of artillery. He was one of the younger of a numerous family of children; of whom none now survive, except Col. William Whistler, of the 4th regiment of infantry.

Upon the reduction of the army after the war, Major Whistler, the father, was among those not retained; from the circumstance of his having already two sons in the service. But he accepted the post of military storekeeper at Newport, Kentucky; whence he was transferred to St. Louis, and died in a good old age. The family had indeed been removed to Newport, while Whistler was still in childhood; and he received there his early education. But still earlier education and continual association had inspired him with a taste for military life, to which other circumstances were not adverse, and accordingly we find him entered as a cadet at West Point in 1814.

A change in the regulation of the Academy after his entrance, gave him the advantage of a longer course there than is now required. He remained five years as a cadet; and graduated in 1819. He did not

then quit the Point; but remained under orders as Assistant Professor, for which his attainments in descriptive geometry and his artistical taste and skill in plans and drawings peculiarly fitted him. This fitness, indeed, extended itself to the fine arts generally; his aptness for the arts of design was associated equally with a predilection for music, which upon more than one instrument raised him to the first rank of amateur performers. It is remarkable that such tastes should have co-existed with an almost irresistible fondness for the associations of a military life; whose results (at least in time of war) are rather those of destruction than of creation. It is not less remarkable that they should have continued to be developed till past the meridian of life, amid all the pressure of graver employments and momentous exertions.

His employment as Professor continued for nearly two years. In 1821, although commissioned in the artillery, he was detailed on topographical duty under Major (now Colonel) Abert; the present chief of the Bureau of Topographical Engineers. For such service, the taste and attainments just spoken of peculiarly fitted him; and they were recognized and still farther usefully applied the following year, when he was detailed as Draughtsman to the Northern Boundary Commission.

It was in the interval between these two engagements, that he contracted another in the marriage with his first wife, the lovely daughter of the late Dr. Swift, U. S. A. Death dissolved this tie in 1828.

His labors with the surveyor, connected with the Boundary Commission, between the Lake of the Woods and Lake Superior, continued for four years; extending from 1822 to 1826. And subsequent duties in the Cabinet of the Commission employed nearly two years more.

About this period, the stimulus which the interest manifested by the general government in internal improvements had given to works of that character, created a new demand for the services of persons competent as surveyors and engineers; which the class of such persons existing in civil life was not able to supply. To the army, therefore, whose officers had had opportunity for the requisite education, and especially to those who had already been familiar with topographical duty, frequent applications were made.

Among others, the Baltimore and Ohio Railroad Company, one of the earliest corporations for such a purpose in this country, had been successful in obtaining the aid of several officers who were then eminent or have since become so. The names of Doctor Howard, who though not a military man, was yet attached to the Corps of Engineers of the Army, of Lt. Col. Long, and of Capt. McNeill, appear in the proceedings of that company as Chiefs of Brigade; and those of Fessenden, Gwynn and Trimble among the assistants. In Oct., 1828, this company made further special request for the services of Lt. Whistler; and this, it may be supposed, from his known capacity and the company's need, not so much for general purposes as for particular aid. The directors had resolved upon sending a deputation to England to examine the characteristics of railroad undertakings there; and no one could have been better calculated to serve on such a mission than Whistler. The other members were Capt. McNeill and Jonathan Knight, Esq.

Leaving this country in Nov., 1828, directly after being joined by Whistler, they returned in May, 1829. In the course of the following twelvemonth, the organization of the road (a part of which had already been constructed under the immediate personal superintendence of W.) assumed a more permanent form; this allowed of the transfer of the Military Engineers to other undertakings in a more inchoate state, where similarly beneficial services could be rendered with those that the Baltimore and Ohio Railroad had already enjoyed.

Accordingly in June, 1830, Capt. McNeill and Lt. Whistler (he had, in 1829, been promoted) were detailed to the Baltimore and Susquehanna Railroad; for which they made the preliminary surveys and definitive location. It is perhaps, at least in a financial aspect, to be regretted that their advice was not followed in the general direction to be given to the line. Instead of its penetrating northward to drain the freights of the Upper Susquehanna, it would have been carried more eastwardly to intercept those freights at or near the mouth of that river, and to attract besides the passenger travel from Philadelphia, the distance between which and Baltimore it would so materially have shortened. In point of fact, it would have anticipated the realization, consummated not till nine years afterwards, of the present Baltimore and Fort Deposit railroad; and would have stimulated, at the most favorable period, the normal development of these constructions as thoroughfares of travel more than channels of trade.

However, these topics need not be discussed here. They are only referred to at all as an early manifestation of that prompt sagacity to which it may be presumed Whistler contributed his proper share; for since their connection in 1828, these two subsequently so distinguished engineers appear identified by an intimacy, if possible, more than fraternal.

In the latter part of 1831, Whistler went to reside in New Jersey in furtherance of the Paterson and Hudson railroad; a work then recently commenced: and from his various residences in that state, at Paterson, at Aquachnonk and at Belleville, he attended to the construction of this and the Boston and Lowell railroad—both in progress at the same time.

In 1833, he resigned his commission in the Army of the United States; not so much from choice as from a sense of duty. And at this epoch and possibly from this event, there seems to have been a turning-point in his character. Hitherto, his pursuits as an Engineer appear to have been more in the aspect of an employment than of a vocation; he prosecuted his undertakings diligently, to be sure, as it was his nature to do, but without much anxiety or enthusiasm; and he was satisfied in meeting the difficulties as they supervened with a sufficient solution. Henceforward, he handled his profession more *con amore;* he labored that his resources against difficulties of matter and space should be over-abundant; and if he was before content with the sure-footed tact of observation, he now added the luminous aid of study. How luminous and how sure these combined became, his subsequent works tell best.

In the fall of 1834, he left New Jersey and went to New London to superintend more conveniently the inception of the Providence and

Stonington railroad; a work intended as the complement of the Boston and Providence railroad, then almost completed. Not long after, in 1835, he yielded to the urgent solicitations of friends and parties interested (in both classes of whom may be mentioned, for instance, the late Patrick Jackson,) and assumed the position of Superintendant and Engineer of the machine shops, principally for the construction of locomotives which the Locks and Canal Company of Lowell had recently established. Here he remained for two years or more, to the advantage of the Company, and to the increase of his own stores of mechanical knowledge. We observe throughout his life, but perhaps most prominently in these very engines built under his direction, the self-denial with which he excluded novelties of his own, the caution with which he admitted those of others, and the judgment which he exercised in selecting and combining the most meritorious of existing arrangements.

This preference for what was simple and had been tried, did not arise from a want of originality, but pure self-command. On the contrary, those who have been associated with him can recollect how ready he was at all times with devices for facilitating the execution of work, or remedying contrarieties and disasters as they occurred. His simplification of the method of running curves on the ground may be taken as an instance, occurring when he happened to be visiting a work of great importance under the charge of an eminent brother engineer. The heads of the long wooden piles that were being driven became always shattered, and though ferruled with a ring, split under the blows of the driver. Whistler immediately suggested the interposition of a loose sheet-iron plate, to be placed on the head of the pile and to answer the purpose of equalizing and dispersing the forces. It is hardly necessary to add that the expedient was successful.

After a while, in 1837, the condition of the Stonington railroad became such as imperatively to demand his presence and attention; and he removed for the purpose from Lowell to Stonington. At the same time he was called to take part in conjunction with McNeill and Swift in the location and construction of the Western railroad. In these connections he remained until 1840; when he found it more convenient, in behalf of the last named railroad, to remove with his family to Springfield. There he still was, when in 1842 he was invited in a manner highly gratifying to himself and honorable on the part of the Emperor of Russia, to assume the charge of certainly the most gigantic undertaking of the age, the Petersburg and Moscow railroad. This position was offered to him, not so much because he was an American, as for his own high qualifications. A deputation of Russian engineers who had visited America the year before, had occasion to remark his extraordinary abilities and made report accordingly upon their return; and this led to the invitation. This fact need detract nothing from our national pride. Whistler, *the man*, after his transferal to another continent became eminently *the American;* and his abilities thus advanced the reputation of his country beyond any thing that could have been predicted of it before.

The general direction and intent of this great railroad had been determined upon before he was called in; and the executive control of it

had been vested in a Commission consisting of high officers of state, and among them, persons of large scientific attainments. Of this Commission, Whistler was shortly made a member; the minute surveys, the location of the line, and it may be even said all particulars in its construction, which could properly come under the purview of executive consideration, were directed or approved of by him. And in those points where his experience or reflection suggested an opinion different from that of his colleagues, he had the fortunate tact to win golden opinions from those even whose views he did not sustain. We believe that we only state the simple truth in saying, that year by year he rose in the estimation of those with whom he was engaged.

The difficulty of his task, arising from the very grandeur of the undertaking apart from any local or physical obstacles, is not to be judged of by anything in the professional experience of any other engineer, living or dead. A road of four hundred and twenty miles, with a thirty feet base, a road way of four hundred feet in width, a double track of seventy pound rails on a five feet gauge, with an equipment of one hundred and sixty-two locomotives and more than two thousand six hundred cars, for whose manufacture the place and means had to be as it were created amid those Sclavonic plains—all to be opened and furnished almost simultaneously, at an expense of forty millions of dollars in the short space of seven years—constitutes an undertaking that might have paralyzed many a stout and self-relying heart. Fifty thousand men—a force to subvert a kingdom or establish an empire—worked together at once to force the Earth's reluctant materials and products to submit to the forms of a severe geometry. Upon one man, rested in great measure the responsibility of the issue of this large number of hands. Such and so great was the task that awaited him.

The progress made in its completion was such that in March, 1847, the Emperor with his suite was able to travel over a part of the road and inspect the shops where all the immense machinery was being fitted. Upon this occasion, which seems to have been regarded as a sort of celebration, divers promotions were made among the native officers connected with the work; and the Cross of the Order of St. Anne was conferred upon the American Engineer as a token of the estimation in which he was held.

Honorable tokens of another kind were not few. Besides the appropriate work of his functions on the road, enough to try the energies of one man, (who, whatever might be his abilities, could not make more than twenty-four hours in a day, nor be in two places at once,) various other calls were at times made upon Whistler; implying a seeming belief in his universal knowledge. Thus, not long after commencing the great work in 1843, he was consulted upon the project of the docks and fortifications at Cronstadt where his ideas received—no mean praise—the imperial approval. Then the plans for improving the Dovina at Archangel, and the construction of a permanent bridge across the Neva, where the difficulty arises not so much from the width (only eight hundred feet) as the depth and rapidity of current, were successively submitted to him. The design of an iron roof of a riding-house at St. Petersburg which exceeds the enormous span (two hundred and thirty-five feet) of that at Moscow, was en-

tirely left to him. Finally his last appointment was that of Engineer of the Naval Arsenal at Cronstadt; a work which, had he survived, would doubless have been executed with the success that attended his other undertakings.

In the midst of all this activity and usefulness, his seven years' engagement having expired to a month, the railroad so far complete that it could be delivered over without much urgency in twelve month's time, just as, with his family (for, as we should before have said, he had married, in 1832, the accomplished sister of his friend McNeill) he was about to revisit for a brief interval his native country—death called him away from his labors. His health had not been so robust as usual for several months past; and an attack of sickness supervened, from which, however, there appeared no cause to apprehend a disastrous issue. But on the 6th of April, there came a sudden crisis; he gradually sunk and expired peacefully on the morning of the following day.

Every mark of respect, we are informed, was paid by the government; and the direct condolence of the Emperor with the bereaved lady will be remembered with melancholy pleasure. It is to be presumed that our own government, which has recently so readily and honorably responded to the appeal of an anxious British wife, will not be backward in testifying proper respect to the remains of one who has done so much to sustain the American character abroad.

A few more words, and this notice must be closed. As an engineer, Whistler's works speak for him. He was eminently a *practical* man; though hardly in the sense in which that phrase is frequently used. For it is not going too far to say that no American cotemporary at least possessed more of the theory of his profession or of the science of engineering, which unfortunately in this vehement age is too often considered secondary to the impulses of, so-called, genius; while it is forgotten that *science is genius taught by experience*—experience, not one's own alone, but that of others, too. With such views, Whistler had no affinity. Accustomed to study his combinations, until he could with prophetic science (so to speak) almost divine their issue, none of his results are to be classed among the happy crudities or fortuitous successes of the mere practical man: the end was foreseen from the beginning, and the beginning calculated for the end.

As a man, his character may be traced in the words—truth and modesty. A blameless youth had been succeeded by a manhood of deep religious feeling and piety unfeigned. Though we cannot but sorrow at parting with an old friend, and regret his being cut off ere he had attained the ripest maturity of power and performance, we yet bow at the inscrutable decrees of a beneficent Providence; for our sorrow and regret are mingled with the assurance that "the righteous is taken away from the evil to come." A.

14. Stephen Endlicher, (Athen., No. 1122.)—We have to announce the death of Dr. Stephen Endlicher, Professor of Botany at Vienna. He was well known in Europe, both as a botanist and as an accomplished philologist,—and held the situation of Librarian to the Imperial Library at Vienna. One of his earliest contributions to botanical science was his 'Flora Posoniensis'—which was published in 1831. The plants were arranged in this 'Flora' according to the natural sys-

tem; and throughout the whole of his botanical career, Professor Endlicher has paid great attention to the systematic arrangement of the vegetable kingdom. In 1836, he published his great work entitled 'Genera Plantarum, secundum ordines naturales disposita.' At the time when it was published, it was undoubtedly the most important work on systematic botany since the 'Genera Plantarum' of Jussieu. In this work he proposed an arrangement of the vegetable kingdom which has had a considerable influence on more recent systems. He also published several works containing descriptions and drawings of new plants. Those brought from Peru and Mexico by Poeppig were described by Endlicher. In 1837, he commenced the publication of a work containing descriptions and drawings of new species of plants, under the title, *Ατακτα Βοτανικα*. The drawings for this work were from the pencil of the celebrated Ferdinand Bauer; who died at Vienna in 1826,—and who, like his brother Francis in England, left behind him a great number of drawings of plants such as had never been equaled during their lives and have scarcely been surpassed since. Endlicher published a Flora of Norfolk Island in 1833; consisting of descriptions of plants which were collected by Ferdinand Bauer in 1804 and 1805. In addition to these systematic works, in conjunction with Unger, Endlicher published a work on structural and physiological botany. This work is interesting as containing a statement of its author's views of structure upon which his systematic arrangements are founded:—but it was not in this department that Endlicher obtained his reputation as a botanist. It was reported that the death of Endlicher was caused by his own hand:—but this appears to be untrue.

V. Bibliography.

1. *De Candolle's Prodromus Regni Vegetabilis: Pars XIII, Sectio Posterior.* Paris. pp. 468. May 5, 1849.—This half volume has appeared very nearly at the date announced for it, last autumn, when the twelfth was published. It is the *second* part, anticipating the first, which is to contain the *Solanaceæ* and the *Plantaginaceæ*, two families which will finish the Monopetalous series, as this begins the Apetalæ or *Monochlamydeæ*. It comprises the *Phytolaccaceæ*, *Salsolaceæ* (Chenopodeæ), *Basellaceæ*, and *Amarantaceæ*, elaborated by Moquin-Tandon of Toulouse, and the *Nyctaginaceæ*, by Prof. Choisy of Geneva. Of *Phytolaccaceæ* we have, in the United States, only Petivera alliacea which grows in Florida (probably not in "Carolina"), Rivina lævis, (to which we are surprised to see R. portulacoides, *Nutt.*, joined,) and Phytolacca decandra, which last is now so widely dispersed over the world that its native country is uncertain.

The large family of *Salsolaceæ* comprises 72 genera, disposed nearly as in Tandon Chenopodearum Enumeratio, in two suborders and seven tribes, most of which are further divided into subtribes. Our genera of the Cyclolobeæ (those with the embryo nearly annular) are *Aphanisma*, Nutt., a Californian plant discovered by Mr. Nuttall; *Teloxys aristata*, which is credited to us because Linnæus referred his Chenopodium Virginicum to C. aristatum, but it is doubtful if we possess the genus; *Cycloloma* (Salsola platyphylla, *Michx.*); *Chenopodium*,

to which Tandon now reunites the greater part of his Ambrina, (C. ambrosioides, C. anthelminticum, &c.,) leaving in *Roubieva* only the original species, recently illustrated in this Journal by Mr. Carey; *Blitum*, to which the author now refers, as a section, his former genus, *Agathophyton* (Chenopodium Bonus Henricus, *L.*); *Monolepis*, Schrad. (Blitum chenopodioides, *Nutt.*) *Atriplex*, of which too many of the older species are credited to the United States; *Obione*, Gærtn., of which nine species are North American, including (apparently with sufficient reason) the Pterochiton, *Torr.; Grayia*, Hook. and Arn., of a single species; *Eurotia;* a doubtful *Kochia;* a *Corispermum* (which Tandon seems not to know as also a native of this country); *Salicornia*, in which we have S. herbacea? S. Peruviana (Caro. Fraser), and S. Virginica, to which last he evidently would refer S. mucronata, *Bigelow*, a name unknown to him (and he has also dropped, apparently by accident, the homonym of Lagasca, so that the point in which we are interested is not elucidated); *Arthocnemum* (A.? ambiguum = Salicornia ambigua, *Michx.*) being still kept distinct. Of the SPIROLOBEÆ we have in North America, *Chenopodina*, a genus newly founded for the Chenopodium maritimum, L., which was formerly referred to Suæda, besides which species Tandon also gives us C. linearis (the Salsola linearis, *Ell.*, which however he thinks may be a variety of C. prostrata, which again he thinks may not prove distinct from C. maritima), and C. depressa (Salsola depressa, *Pursh*); of *Shoberia*, we have S. calceoliformis (Chenopodium calceoliforme, *Hook.*), which is stated also to be found "near New York;" of *Salsola*, we have S. kali only. The singular genus *Sarcobatus* of Nees, (the *Fremontia* of Torrey in the Reports of Fremont's first and second journeys,) is enumerated among the *Genera exclusa*, and said to be "*dubiæ sedis.*" Probably the author had not seen the figure of the fertile plant published by Dr. Torrey. *Acnida*, following the aspect and inflorescence, is here referred to the Amarantaceæ.

The order *Basellaceæ*, familiar to us only by the Boussingaultia baselloides, which is cultivated as an ornamental climbing plant, contains six genera, entirely of tropical plants.

The order *Amarantaceæ* includes forty-five genera, arranged under three tribes. There are credited to this country, *Celosia*, one Californian species; *Amarantus* about nine species; *Mengea*, Schauer, a Californian species which has much the aspect of Amarantus Blitum; one or more species of *Euxolus*, Raf., (Amarantus lividus, *L.* &c.); *Acnida*, in which A. rusocarpa appears to be mixed up, in a manner that requires much investigation to unravel, with Amaranthus tamariscinus, *Nutt.*, which again, though entirely distinct from Acnida itself, nearly accords in character with Moquin-Tandon's section Montelia; *Banalia*, a new genus, one section of which includes an Oregon species (Halomocnemis occidentalis, *Nutt. ined.*); an obscure *Polycnemum; Gossypianthus*, Hook, two Texan species; *Iresine*, two species; *Alternanthera*, one species (Achyranthus repens, *L.*), besides the A. (Cladothrix, *Nutt.*,) lanuginosa, which Lindheimer and Wright find abundantly in Texas, and which will certainly stand as a separate genus, if a striking peculiarity in respect to its fruit, observed by Dr. Torrey, proves to be a normal condition. *Telanthera* ficoidea and polygonoides

appear to be only introduced plants along our southern coast. *Frœlichia* (Oplotheca, *Nutt.*) has three North American species. *Phyllepidium* of Rafinesque is not identified, and probably never will be.

The remaining family, *Nyctaginaceæ*, includes eighteen genera, in three tribes. Of *Mirabilis*, though no species are credited to us, we have one or more in Texas, as well as the three species of *Nyctaginia*, Choisy. Of *Oxybaphus*, six North American species are indicated; and the Peruvian *Alliona incarnata* comes also from California. Four species of *Abonia* are described, besides A.? (Tripterocalyx) micrantha, *Torr.*, which Dr. Torrey has since raised to the rank of a genus. *Pisonia aculeata* is found on Key West. *Boerhaavia* furnishes us three or four species; and there still remain some undescribed Texan representatives of the family. A. Gr.

2. *Catalogue of Plants, Native and Naturalized, collected in the vicinity of Cincinnati, Ohio, during the years* 1834–1844; by Thomas G. Lea. Philadelphia. pp. 77, 8vo. 1849.—The circumstances under which this posthumous publication has been made, from materials which, had Mr. Lea's life been spared, would have assumed a more extended and important form, are thus briefly stated by Mr. Sullivant, in the preface.

"Few botanists have more thoroughly investigated the vegetation of their immediate vicinities than did the late Thomas G. Lea that of Cincinnati. This is apparent not so much in the large number of plants here enumerated and determined with singular accuracy, as in the copious and valuable observations attached to the specimens in his Herbarium. These observations, had life and health been spared to complete them, would have appeared in the form of a local Flora—a work for which years of assiduous study of the plants of Southwestern Ohio had well fitted him.

"The following Catalogue, however, is all that he left ready for publication; with the request that Mr. J. Carey, of New York, or myself, should see it through the press. In the Phænogamous portion no changes have been made other than in the nomenclature, rendered necessary by the advance of the science since the period of his decease. During the last three or four years of his life, Mr. Lea was zealously devoted to the study of Fungi: and his collections in that department will be found a highly valuable contribution to the mycology of the United States. Mr. Lea died of an autumnal fever, on the 30th of September 1844, at Waynesville in this State, where he had been passing a few weeks, making, as these pages will attest, many new and rare collections in the adjacent valley of the Little Miami river. In accordance with his wishes, all the specimens of Fungi were submitted to his correspondent, the Rev. M. J. Berkeley of England, by whom alone they have been determined and prepared for this Catalogue."

The Phanerogamous plants, Ferns, Mosses, and Hepaticæ, appear in the form of a naked Catalogue. The account of the Lichens, prepared by Mr. Tuckerman, is enriched by some critical remarks by this skillful Lichenologist, and by the characters of three new species of Lichens proper, namely *Verrucaria subelliptica*, *Parmelia Leana*, and *P. hybocarpa*, and of a Collemacea, viz., *Leptogonium corticula*, to which

an extended note is appended. But far the most valuable part of Mr. Lea's collection consists of the Fungi, which he long made the objects of special study. The catalogue of this family, prepared by the Rev. Mr. Berkeley, is a most important and timely contribution to our knowledge of an obscure and neglected branch of our botany, from one of the most accomplished Mycologists of the age. It comprises the characters of fifty-three new species of the order. A. Gr.

3. *The Elements of Botany;* by M. Adrien de Jussieu: *Translated by* James Hewetson Wilson, F.L.S., &c. London: Van Voorst, 1849. pp. 750, 18mo.—We are glad to have an English translation of this invaluable elementary work, which was briefly noticed in this Journal soon after the publication of the first edition of the original. It is without doubt the best compendious treatise on the subject that has appeared in any language; and appears to be, on the whole, well rendered into English by Mr. Wilson; and the excellent cuts are accurately copied. It is to be hoped that many copies will find their way to this country.

A. Gr.

4. *A Manual of Botany; being an Introduction to the study of the Structure, Physiology, and Classification of Plants;* by John Hutton Balfour, M.D., F.L.S., &c., Professor of Botany in the University of Edinburgh. Illustrated by numerous wood-cuts. London: I. Griffin & Co. 1849. pp. 641, 12mo.—We have here an original English introduction to Botany, but modeled evidently upon the plan of Jussieu's, all of whose wood-cuts (from the English edition) have been borrowed, as well as several others from different sources. In extent, it is about the proper size for a class-book, being intermediate between the terse "Outlines" of Henfrey and the large octavos of Lindley. Indeed it aims to cover the whole ground of Dr. Lindley's series of works, only half the volume being devoted to Vegetable Anatomy, Organography, and Physiology; while the systematic portion gives with considerable fullness the characters of families and the properties and uses of plants; and the part upon Geographical Botany comprises an excellent digest of that interesting department, brought up to the present state of the science. To this is added a brief account of Fossil Botany, and a short appendix, on the use of the Microscope in botanical researches, and on the mode of collecting, examining, and preserving plants. The index is also made to serve as a glossary, in the manner with which we are here familiar. The work is well executed, and the materials judiciously selected, so as to give a good summary view of almost every topic which pertains to the science. A. Gr.

5. *Circular prepared by direction of the* Hon. Wm. Ballard Preston, *Secretary of the Navy, in relation to the Astronomical Expedition to Chile;* by Lieut. M. F. Maury, U. S. N., Superintendent of the National Observatory. 34 pp. 4to, with Charts and Tables. Washington, 1849.—This circular gives a brief history of the important expedition to Chile, under Lieut. Gilliss, and of its outfit in Astronomical Instruments, besides Charts and Tables to facilitate observations. We cite the following, by Lieut. Maury, from the second page of the pamphlet:

The Series of Astronomical observations, in which the coöperation of other observers is more especially invited, will consist of differential measurements, during certain portions of the years 1849, '50, '51 and

'52, upon Venus and Mars, with certain stars along their paths. The observations upon Venus which will most command the attention of the Expedition, will be differential measurements upon that planet, in the morning and evening, while it is near the inferior conjunctions of 1850 and 1852. In like manner, Mars will be compared with its neighboring stars near the times of opposition of that planet in 1849 and 1852. The object of these observations upon this planet, is a more accurate determination of its parallax.

To facilitate the observations and to secure concert of action, so that the coöperators, in whatever part of the world, may, in observing the planets, always use the same stars of comparison, Lieut. Gilliss has prepared the accompanying charts and tables. Charts No. 1 to 5, inclusive, refer to Venus; 6 and 7 to Mars. They show the approximate places of the planets from day to day relatively to the stars, down to the tenth magnitude, near their path. In some parts of the paths of the planets, along which published catalogues do not afford proper stars of comparison, special observations have been made with the large Refractor of the National Observatory; the stars, whose approximate places have been thus obtained, are mapped down along the planet's path. Tables 1 and 2 contain the Ephemeris of the planets, and the stars of comparison. They give the star of comparison for each day, and quote its magnitude with its approximate mean place only. The stars marked W. C. are from the unpublished observations of the Washington Catalogue; as they have not undergone their final reductions, their declinations are only given to the nearest 10″. The other stars are designated by the initials or name of the Catalogue from which they are taken. In the Ephemerides of the two planets and their neighboring stars, the mean places of the stars for 1st January of the year for which the Ephemerides are calculated, are given. The object of such Ephemerides is to give the place of the star with accuracy sufficient merely to leave no doubt as to the identity of the particular star, which all observers are requested to use during the observations for the day thereby provided for. It is requested that those who may have the goodnes to coöperate in these observations will observe the planets also, both for R. A. and Dec., at their meridian passage.

The order of observations, proposed by Lieut. Gilliss, is this:—During the term of the Ephemeris of Mars, differential measurements upon that planet, and the star of comparison for the day, will be commenced at two hours after the passage of the planet across the meridian of Greenwich, and be continued for one hour and a half after the star and planet shall have passed the meridian of Washington; observing and comparing with the star, the North and South Limb of the planet alternately.

Both the planet and star of comparison will also be observed, with the Meridian Circle, at their transit across the meridian of the Observatory in Chile. The same course is proposed to be pursued, at meridian transit, with regard to Venus and her star of comparison. Lieut. Gilliss proposes to commence the differential observations upon Venus and her star of comparison, as given in the Ephemeris, as early in the evening and morning, and to continue them as long, as the light of the

Sun and the conditions of the atmosphere may admit. Owing to the absence of stars of sufficient magnitude within 15° of the Sun, an omission is made in the Ephemeris during the time that the planet will be within that distance of the Sun. It is proposed, during such intervals, to rely exclusively on meridian observations, both at the Observatory in Chile and elsewhere.

The precise place in Chile, at which the Observatory is to be erected, will not be decided upon until the arrival there of the Expedition.

Those Astronomers, who are disposed to forward the objects of the Expedition so far as to coöperate with it in conducting an auxiliary series of observations, will perceive that the results of their labors will be enhanced by using, whenever practicable, the stars of comparison which Lieut. Gilliss has selected, and which are given in tables 1 and 2, and by following generally the plan of observations proposed by him and herein explained. Each co-laborer is requested to send annually, to the Superintendent of the National Observatory, at Washington, his observations, with an account of the instruments with which they were made, together with such other information in relation thereto as is necessary to a full understanding and appreciation of them and the results arising therefrom.

6. *Introduction to Meteorology;* by DAVID PURDIE THOMSON, M.D., Grad. Univ. Edinb., Licent. Roy. College of Surgeons, Edinb. 486 pp. 8vo. Edinburgh and London. 1849, Wm. Blackwood & Sons.—The work on Meteorology by Dr. D. P. Thomson, ranges over the whole field of meteorology in its widest sense, including the general characters of the atmosphere, chemical and physical, barometric, thermometric and hygrometric, as well for heights as for the ordinary level, and for all zones. The causes of the distribution of temperatures are considered —the color of the atmosphere—various properties of light—clouds, rain and snow and all allied phenomena in their many details, even to "Dust-rains," "Fish-rains," "Frog-rains," and "Blood spots;"—also mirage, and lightning in all its varieties of action and effects;—meteors and their theories and supposed agency;—auroras, and other lights to the "ignis fatuus:"—winds and their theories; and descriptions of various instruments for meteorological observation. There is in some departments a want of system in the presentation of the facts and of discrimination in their selection and condensation, which interfere with the scientific value of the work,—a defect which may however increase its popular interest. The chapter relating to winds abounds in the wonderful, with too little true science. Various incidents are introduced by way of illustration that give variety to the subject treated, and an excellent literary taste pervades the work.

7. *A Memoir on the Geological Action of the Tidal and other Currents of the Ocean;* by CHARLES HENRY DAVIS, A.M., Lieut. U. S. N. —From the Memoirs of the American Academy of Arts and Sciences, New Series, vol. iv, 40 pp., 4to, with three maps. Cambridge. 1849.—No observations at the present time can better promote the progress of geology than those relating to the tidal currents of the ocean and the distribution of material thus produced: and science owes much to Lieut. Davis for the exposition of this subject which he has made. Our coast affords facts of a most extended and varied character, and

we may hope that similar observations will soon be extended along its whole outline. The investigations here detailed were made about the Nantucket shoals and Long Island. The author exhibits in a strong light the action of the tides in the accumulation of the loose material constituting shoals, and in determining their positions and outline.

8. *Sixty-second Annual Report of the Regents of the University of the State of New York;* made to the Legislature, March 1, 1849. 392 pp. 8vo. Albany. 1849.—This Report, besides its fund of information relating to education in New York, contains, as heretofore, meteorological tables for the year, made throughout the state and various observations on different atmospheric phenomena. There are also some pages devoted to topographical and other information relating to portions of the state and even to other states, a part of which are valuable, and another part add nothing to the reputation of the Report.

9. *Reports, etc., of the Smithsonian Institution, exhibiting its Plans, Operations and Financial Condition up to January* 1, 1849. From the third Annual Report of the Board of Regents: Presented to Congress, Feb, 19, 1849. 72 pp. 8vo. Washington. 1849.—The objects and plan of the Smithsonian Institution have been noticed at length in a former number of this Journal. It is gratifying to learn that these plans, so noble and comprehensive, are in process of accomplishment under the supervision of its learned Secretary, Prof. Henry.

10. *A collection of Tables and Formulæ useful in Geodesy and Practical Astronomy, including Elements for the Projection of Maps;* prepared by order of the Topographical Bureau for the use of the Corps of Topographical Engineers; by Capt. T. J. Lee, Topographical Engineer. 96 pp. 8vo. Washington. 1849. No. 3 of Papers relating to the duties of the Corps of Topographical Engineers.—The Topographical Bureau of our Government, under the general direction of Col. J. J. Abert, is conferring a great benefit on the science of the country, by its recent publications. The work before us has more interest than pertains to a manual for Engineers: its utility will be appreciated by a wide range of readers. It presents in a perspicuous manner the various trigonometrical expressions, formulas and series used in calculations, commencing with the most simple; embracing equations for the circumference and arcs of circles—and for sides and surfaces of triangles:—next explains fully the standards of weights and measures, giving many tables, including long comparative tables of English and French measures, &c.: then passes to Expressions for Surfaces and Contents of Solids of various kinds—Formulas in Hydrometry—Expressions for Arithmetical and Geometrical progression—Force of Gravity—Tables and Formulas in Geodesy, drawn out with the fullness of detail required in the most thorough surveys, with extended tables for the various corrections, as of temperature, the earth's ellipticity, &c.—Tables of Corrections for Refraction in Trigonometrical altitudes—Table of Slopes for given ratio of altitude—Full rules for Barometrical determination of Heights, with several tables for corrections, and others for the comparison of different thermometers, and for French and English barometers—Rules for the Thermometrical Measurement of Heights—Formula for projection of Maps, with a number of valuable tables—Table of the lengths, in Nautical and Statute miles, of degrees

of Latitude and Longitude in different Latitudes—Tables of formula for Astronomical observations, and especially for determination of Time, Latitude and Longitude. Such a number of useful tables and formulas—and we have given but a partial enumeration of them—have never before been brought together in the same compass. Moreover we cannot commend too highly the clear typography of the volume, and the perspicuity of its arrangement, nor the apparent care and labor with which the work has been prepared by Captain Lee.

11. *Description of a System of Military Bridges with India Rubber Pontons, prepared for the use of the United States Army;* by Capt. GEORGE W. CULLUM, U. S. Corps of Engineers.—Paper No. 4, from Papers on Practical Engineering, published by the Engineer Department, for the use of the Officers of the United States Corps of Engineers, pp. 274 to 414 and plates 18 to 22 inclusive. The valuable memoir whose title is here cited, is illustrated by full details, giving all the particulars required in the construction of Bridges with India Rubber Pontons.

12. *Transactions of the New York State Agricultural Society, with an abstract of the proceedings of the County Agricultural Societies.* Vol. viii. 1848. Albany. 1849. 8vo., pp. 975.—The able and industrious secretary of the State Society, has placed this huge volume in our hands. Its contents are various, but important and interesting—worthy of the state from whose public assembly this volume issues as a part of their legislative proceedings. Mr. Salisbury's memoir on the chemical constitution of Indian corn, forms a part of this volume. The addresses and proceedings of the Society and the agricultural returns of the several counties of the state, agricultural discussions on various topics by the members of the State Society, occupy a large part of the volume, which is concluded by an agricultural survey of Washington county, by Dr. Asa Fitch. Among the most important matters discussed in this volume is the subject of a Normal Agricultural School, to be established by the State government, for the proper promotion of agricultural education and research. This is a subject of commanding importance, and it behooves the state of New York to set a liberal and enlightened example in this respect.

13. *History and Chemical Investigation of Maize, or Indian Corn;* by J. H. SALISBURY. Albany. 1849.—This research is a "Prize Essay," to which the New York State Agricultural Society have awarded their premium of $200, offered two years ago. This "Essay" forms part of the valuable volume of Transactions of the Society for this year, just published as above noticed.

Mr. Salisbury's research is very elaborate and extended. It is embodied in 206 octavo pages, a large part of which is taken up with closely printed tables of analytical results, and of calculations deduced from them. We have received this essay at the moment of going to press, and have had no opportunity to make a critical examination of Mr. Salisbury's methods or results. We have however, seen enough to know that great labor has been bestowed on this research, and that the author's attention has been devoted to a wide range of inquiry in reference to the chemical constitution of all parts of this great American staple grain, and of the soils and manures upon which it has been

grown. It is also evident, that our knowledge of the chemical history of this grain, is greatly extended by Mr. Salisbury's labors. We promise ourselves the pleasure of again reverting to this memoir on another occasion, when we can have space to take it up somewhat in detail. We must now confine ourselves to the following table (Table 60 of the memoir) exhibiting the composition of the *ash* of the kernels of three varieties of maize.

	No. 10. Ash of kernels of the Chinese tree variety.	No. 11. Ash of kernels of the Tuscarora variety.	No. 15. Ash of kernels of the R. Island sweet variety.
Carbonic acid,	trace.	trace.	trace.
Silicic acid,	1·700	0·775	1·125
Sulphuric acid,	1·075	1·275	0·550
Phosphoric acid and peroxyd of iron,	49·185	44·135	44·050
Lime,	0·620	0·395	0·335
Magnesia,	16·200	12·875	12·810
Potash,	12·930	14·240	12·867
Soda,	15·365	20·545	22·968
Chlorine,	0·440	0·450	0·270
Organic acids,	2·125	3·520	3·025
	99·640	98·210	98·000

14. *Notes on the Medical Application of Electricity;* by WILLIAM F. CHANNING, M.D. Boston: D. Davis, Jr. and J. M. Wightman. 1849. 12mo, pp. 199.—This unpretending little volume emanates from a source which entitles it to great confidence as a faithful record of the present state of our knowledge of the application of electricity in the treatment of human disease. The subject is treated under the following heads. 1. Physiological relations of Electricity. 2. Forms of Medical Electricity. 3. Means of Application. 4. General application to disease. 5. Special application to disease. Dr. Channing treats each of these topics in a perspicuous manner, and the last two with special fullness. He gives a decided preference in a majority of cases, to electro-magnetism and magneto-electricity as a means of excitement in medical cases.

15. *Davis's Manual of Magnetism;* by DANIEL DAVIS, Jr. 1848. Boston: 2d edition. 12mo, with 180 original illustrations.—Mr. Davis's Manual has long been a handbook with all teachers and many students of electrical science in this country. It is peculiarly an original and valuable work, and the forms of apparatus which it figures and describes, are now acknowledged to be the best which are in use for experimental illustration. Many minds have united to produce this result, and Mr. Davis has been peculiarly favored in having the advice and assistance in contriving his apparatus, of such men as Prof. Henry and Drs. Page, Channing and Bacon. Under the charge of the two latter gentlemen, the present (as well as the former) edition of this Manual has been principally prepared.

16. *Knapp's Chemical Technology*, vol. ii, illustrated with 246 engravings. Philadelphia: Lea & Blanchard. 1849.—The second volume of this work under the editorship of Prof. W. R. Johnson, has been some time in our hands from the enterprising publishers. The mechanical

execution of these works leaves little to be desired, and the wood-cuts are equalled only by the other volumes of the series of illustrated scientific works of which this is one. This volume is devoted to the detailed description of the process of Glass making in its various departments, and the manufacture of Alum, of Copperas, and of Oil of Vitriol, all of which are subsidiary to Glass making. Groupe III. is devoted to Clay wares, the manufactory of Pottery and Porcelain, including Bricks. Groupe IV. is devoted to Lime, Mortar, Gypsum, Magnesia, Barytes, and Strontia.

Dr. Knapp's happy union of scientific accuracy with a minute knowledge of practical details, renders his works of the greatest value to all who take an interest in the progress of the scientific arts.

17. *The Nautical Slide Rule;* by PAUL CAMERON. 2d edition. London. 1848. 12mo, pp. 58.—The author of this treatise is the inventor of an instrument for the use of navigators, which he calls a Nautical Slide Rule, and another which is called the Mechanical Sliding Rule. These instruments appear to be capable of solving instrumentally or by construction a large range of practical problems, alike in navigation and general mechanics, and withal to be of a very simple and practical character.

18. *Second Report of Experiments on Gunpowder, made at Washington Arsenal in* 1845, '47, *and* '48; by Brevet Major ALFRED MORDECAI, of the Ordnance Department. Washington. 1849.—Major Mordecai's former experiments on Gunpowder and Guns, are well known (see this Jour., i ser., vol. xlix, 180) as having added very greatly to the extent and accuracy of our constants in this difficult department of physical investigation. The following are the principal objects which were proposed in continuing the experiments with the ballistic pendulum:—

1. To ascertain the smallest calibre of gun which may be relied on to give satisfactory results, in using the ballistic pendulum as an instrument for proving gunpowder.

See "Report of Experiments on Gunpowder, at Washington Arsenal, in 1843 and 1844," p. 320.

2. To ascertain the initial velocities of balls fired from field guns and howitzers, with various charges.

3. To ascertain the charge of maximum effect, and also the relative force of a given charge, in guns of various lengths of bore.

4. To extend the experiments on the windage of balls, in order further to develope the law of variation of the force of the charge, with various windages.

5. To extend the experiments on balls of various weights, in order to compare the force of the charge, with different weights of ball, in its effects on the gun, as well as on the shot.

19. *Craig's Universal Dictionary of the English Language, embracing all the terms used in Art, Science and Literature.* 2 vols., 8vo. pp. 1053 and 1100. London. 1849.—Mr. CRAIG is Lecturer on Geology in Anderson's University, Scotland. This dictionary retains in its main features the peculiarities of Walker. Its definitions are full and accurate, being largely derived from Webster. The orthography and orthoepy of the work are of course deeply tinctured by the Old Eng-

lish (Irish?) standard, which is chiefly its basis on these points. It is beyond our province to discourse upon lexicography, but our attention was called to this work by the arrival at a late hour of a copy from the author. It is certainly singular that Englishmen should again be indebted to a stranger for another dictionary of the English language. Thus in succession has an Irishman, an American, and a Scotchman, presented England with lexicons of their own language, compared with which their own works have been imperfect and unpopular.

Proceedings of the American Association for the Advancement of Science.—First Meeting, held at Philadelphia, Sept., 1848. 156 pp. 8vo. *Philadelphia*, 1849.

Report of the Eighteenth Meeting of the British Association for the Advancement of Science, held at Swansea in August, 1848. xl, 98 and 138 pp. 8vo. *London*, 1849. *John Murray.*

J. M. Gilliss: On the Longitude of Washington. From the Proceedings of the American Philosophical Society. *Philadelphia*, 1849.

J. Curtis, F.L.S. British Entomology, being Illustrations and Descriptions of the Genera of Insects found in Great Britain and Ireland. 16 vols. Roy. 8vo. 770 copper plates.—This work is about to be re-issued by Reeve, Benham & Reeve, at about half its original cost—£21 for complete copies to subscribers.

T. Moore: A Handbook of British Ferns. London. 5s.

Proceedings Bost. Soc. Nat. Hist. FEBRUARY. 1849. Epoch of the Mastodons; *H. D. Rogers, Mr. Foster, Desor.* p. 118. New shells of the Exploring Expedition under Capt. Wilkes, (Genera Trochus, Planaxis, Cerithium,) *A. A. Gould.* —MARCH. p. 122. Telluret of lead and gold from Virginia; *C. T. Jackson.*—p. 122. Structure of Glaciers, illustrating laminated structure of rocks; *H. D. Rogers.* —p. 125, same subject; *Desor.*—APRIL. p. 131. On the angles of Arkansite; *J. E. Teschemacher.* p. 132, on the inhalation of nitrous oxyd, chloroform and sulphuric ether; *C. T. Jackson.*—p. 133. Development of Syncoryne; *Desor.*—p. 137. Development of Aurelia aurita; *Desor.*—p. 140. New shells of the Exploring Expedition under Capt. Wilkes. (Genera Pleurotoma, Mangelia, Fusus, Triton, Phos, Murex.)

Bulletin de la Soc. Imp. des Naturalistes de Moscow, 1848; No. II. Insects of Southwest Liberia; *F. Gebler.* Elements for a history of Russian Malacozoology; *Th. v. Middendorf.*—On Spermatophora; *G. Gros.*—Fossil Crustacea of the Jura of Moscow; *A. Vosinsky.*—European species of the genus Corisa; *Fieber.*—On the Glycia virgata and the genus Blechrus; *Motschoulsky.*—Critical Remarks on Erichson's Naturgeschichte der Insekten Deutschland, &c.; *Motschoulsky.*—Decades quarta et quinta generum plantarum adhuc non descriptorum; *Turczaninow.*—On some fossil bones of the government of Orel; *Borissjak.* No. III. Insects of Southwest Liberia; *F. Gebler.*—Flora of Dahura; *Turczaninow.*—Fossil cephalopoda of Kalouga and Moscow; *Fischer de Waldheim.*—On the Saurians of the Zechstein of Russia; *E. Eichwald.*—New Russian Lepidoptera; *E. Eversmann.*—Decomposition of spathic iron by heat; *E. Glasson.*—On Saussurea Karelinii; *S. Stchegléew.* Peloporus destillatorius; *E. Eversmann.*—Botanic notices; *Steven.* No. IV. Anatomical investigation of the Galeodes aronoides and G. intrepida; *M. Kittary.*—Geological relations of the Governments of Orenburg and West Ural; *Wangenheim v. Qualen.*—New Cecindelæ and other insects of Russia; *Chaudoir.*—Fossils of Orel; *Fischer de Waldheim.*—Flora of Dahuria; *Turczaninow.*—Mines of Bielousowsk; *Syranowzk.* —On the beaver; *G. C. Eigenbrodt.*—Analysis of Glaucolite; *Giwartowsky.*—1849, No. 1. Geology of Moscow; *C. Rouiller.*—"Staphylinen Fauna" of the Caucasus and the region beyond; *J. H. Hochhuth.*—On the Crioceras Voronzovii; *Fischer de Waldheim.*—New Siberian Coleoptera; *Mannerheim.*—Comet of August, 1847; *G. I. Schweizer.*—Two venomous spiders of Southern Russia; *Motschoulsky.* —On a Russian Daphne; *J. Kaleniczenko.*—Examination of several minerals; *R. Hermann.*

APPENDIX.

American Association for the Advancement of Science.—The annual session of the American Association was held at Cambridge in Massachusetts on the 14th of August, and the session continued until Tuesday, August 21st, being the longest session yet held by this body. A large number were in attendance from all parts of the country, and the arrangements of the local committee were ample both for the personal accommodation of the members, and for the sessions of the sections. The division into two sections, 1. Of General Physics, and 2. Of Natural History, took place on the second day, and before the close of the meeting, a farther subdivision was made into *four* sections.

The great improvement both in the quantity and quality of the matter offered over any previous year was very observable to those who have followed the sessions of this body from its origin in the Convention of Geologists at Philadelphia in 1840, to its present enlarged and comprehensive form of usefulness. It was obvious that the Association had now become truly national in character, and had taken deep hold of the feelings of men of science and investigators in all departments of knowledge. This manifestation is the best earnest of the future energy and prosperity of the Institution, and gives encouraging hope for farther progress and greater usefulness. Dinner was provided daily for the members in Harvard Hall, and on these occasions the ladies enlivened the hour by their presence—which was extended also to the meetings of the sections. Numerous invitations were received from eminent individuals and public bodies in the neighborhood to visit various objects of interest in science, and on the day after the session closed, several of the naturalists and others accompanied by ladies joined in a dredging excursion in Boston harbor.

The Local Committee and the officers of Harvard College exerted themselves in every way in their power to make the occasion one of pleasure and profit to their guests, many of whom found the most hospitable treatment at their hands, and all were so impressed with the proprieties of the occasion that they will not soon forget the classic shades of the University at Cambridge.

The next annual session of the Association is to be held at New Haven in Connecticut, on an invitation from the officers of Yale College. The President for 1850 is Dr. Alexander Dallas Bache, the Secretary Edward C. Herrick, Esq., and Dr. Ellwyn, Treasurer. The session takes place on Monday, Aug. 19th, 1850. There is also to be a semi-annual session, to be held at Charleston, South Carolina, in March, 1850.

We can give at this late moment only the list of memoirs read at this session, and in the order of the daily announcements.

Tuesday, Aug. 14.

1. On the Aurora Borealis, by Prof. SECCHI of Georgetown, D. C.
2. On the Polar Plant, by Maj. B. ALVORD, U. S. A.
3. On the Plants of Wisconsin, by J. A. LAPHAM, Esq., of Milwaukie.
4. The Fossil Crinoideæ of Tennessee, by Prof. G. TROOST of Nashville.
5. A plan for the Diffusion of Human Knowledge.

Correspondence in relation to the Altona Observatory.

Structure of Coral Animals, by Prof. LOUIS AGASSIZ.

6. On the Fossil genus Mosasaurus and new allied genera in the United States, by R. W. GIBBES, M.D.

Wednesday, Aug. 15. *General Session*, 10 *A. M.*

1. On an American Prime Vertical, by Lieut. CHARLES H. DAVIS.

After the reading of this paper, the members met in two sections, when the following papers were presented,—

SECTION OF GENERAL PHYSICS.

2. On the Natural Classification of Curves, by Rev. THOMAS HILL.
3. On Planetary Perturbations, by Prof. BENJAMIN PEIRCE.
4. On a Comparison of the Results derived in Geodesy from the method of least squares, by Prof. A. D. BACHE.
5. On Boltonite, by WILLIAM SEAMANN, Esq., M.D.
6. On Boltonite, and on Thompson's Bi-silicate of Magnesia, by Prof. BENJAMIN SILLIMAN, Jr.
7. On the Moisture, Ammonia and Organic Matter of the Atmosphere, by Prof. E. N. HORSFORD.

SECTION OF NATURAL HISTORY.

1. On the Zoological Character of Young Mammalia, by Prof. LOUIS AGASSIZ.
2. On the Vegetable Character of Xanthidium of Ehrenberg, by Prof. LOUIS AGASSIZ.
3. On Valerianate of Morphine, a new medicine, by Dr. MORRILL WYMAN and Prof. E. N. HORSFORD.
4. On Footmarks in the Red Sandstone, by I. LEA, Esq.
5. On Volcanos not Safety Valves, by JAMES D. DANA, Esq.
6. On the Remains of a Fossil Elephant, found in Vermont, by Prof. LOUIS AGASSIZ.
7. On the Existence of Remains of Mastodon angustidens in the United States, by Dr. J. C. WARREN.

Thursday, Aug. 16.

SECTION OF GENERAL PHYSICS, CHEMISTY, ETC.

1. On the Relation between the Elastic Curve and the Motion of the Pendulum, by Prof. B. PEIRCE.
2. On the Second Recorded Comet of 1784, commonly called Comet of D'ANGAS, by Dr. B. A. GOULD, Jr.
3. Remarks on Terrestrial Thermotics, by Lieut. E. B. HUNT, U. S. E.

4. On Indianite of Bournon and an American Mineral which has been distributed under the same name, by Prof. B. SILLIMAN, Jr.

5. On the so-called Picrolite and Slaty Serpentine of Texas, Lancaster Co., Pa., by Prof. B. SILLIMAN, Jr.

6. On the Chemical Constitution of the Gorgonia antipathes of Bermuda and the West Indies, by Prof. B. SILLIMAN, Jr.

7. On the Explorations of the Gulf Stream in connection with the U. S. Coast Survey, by Prof. A. D. BACHE.

8. On the Ribbon Structure of Glaciers, and its analogy to Slaty Cleavage, by H. D. ROGERS.

SECTION OF NATURAL HISTORY, GEOGRAPHY, &c.

1. On the Erratic Phenomena of the Central Alps, by Prof. ARNOLD GUYOT.

2. On the Circulation of Fluids in Insects, by Prof. LOUIS AGASSIZ.

3. On the Embryology of Ascidia and the Characteristics of New Species from the shores of Massachusetts, by Prof. LOUIS AGASSIZ.

4. Note on the Mirage on Lake Superior, by Dr. C. T. JACKSON.

5. Remarks on the distribution of Testacean Mollusca in Jamaica and the other West India Islands, by Prof. C. B. ADAMS.

6. On the Erosions of the Earth's Surface, by President EDWARD HITCHCOCK.

7. On the River Terraces of the Connecticut Valley, by President EDWARD HITCHCOCK.

8. Description of Certain Mineral Localities, chiefly in the Northern part of Worcester and Franklin Counties in Massachusetts, by CHARLES HARTWELL and EDWARD HITCHCOCK, Jr.

9. On the Structural Features of the Appalachians compared with those of the Alps and other disturbed districts of Europe, by Prof. HENRY D. ROGERS.

There was a general meeting at Lyceum Hall in the evening, when an address was presented:—

On the progress of the Survey of the Coast of the United States, by Prof. A. D. BACHE.

Friday, Aug. 17.

SECTION OF PHYSICS, CHEMISTRY, &c.

1. Report on the Progress of the Telegraphic Determinations of Difference of Longitude in the U. S. Coast Survey, by SEARS C. WALKER.

2. Experimental Determinations of the Economical Value of British and American Fossil Fuel, by Prof. W. R. JOHNSON.

3. On Leucine, by T. S. HUNT.

4. On the Mineral Waters of Canada, by T. S. HUNT.

5. On the Occurrence of Soda in Anthracite, by Prof. HORSFORD.

6. On the color of fused Sulphur, by Prof. HORSFORD.

7. A new form of Demonstration of the Parellogram of Forces, by Prof. PEIRCE.

SECTION OF NATURAL HISTORY, GEOLOGY, &c.

1. On the Trend of Islands and Axis of Subsidence in the Pacific, by J. D. DANA.

2. On new species of Myliobates, and on new fossils of the Cretaceous and Tertiary of the U. S., by Dr. R. W. GIBBES.

3. Fiords, evidence of a change of Level, by JAMES D. DANA.

4. On the origin of the Drift of the Lake and River Terraces of the U. S., with an examination of the laws of Aqueous Action connected with the enquiry, by Prof. H. D. ROGERS.

5. On some Fossil Remains of Broome County, N. Y., by J. S. REDFIELD.

6. On the Larva of Physocœlus inflatus, by S. S. HALDEMAN.

7. On the Habits of Amphiuma in a state of captivity, by J. L. LECONTE.

8. On some Curious Habits of a Species of Asilus, by J. L. LECONTE.

9. New species of Medusæ, Echinoderms and Crustacea, by Prof. AGASSIZ.

AFTERNOON GENERAL MEETING.—[4½ o'clock.]

1. On the Electricity of a Plate of Zinc buried in the Earth, by Prof. E. LOOMIS.

2. On an Electrical Phenomenon, by Prof. HENRY.

3. On the Supposed Association of Electricity with Cholera, by Prof. HARE.

4. A Letter on Medical Geology, by J. A. LAPHAM.

Saturday, Aug. 18, 10 *o'clock, A. M.*

SECTION OF PHYSICS, CHEMISTRY, &c.

1. On a newly discovered Analogy in the time of the Rotation of the Planets, discovered by Mr. Kirkwood, of Penn., by S. C. WALKER.

2. Phenomena attending Saturn's Ring, by GEORGE P. BOND.

3. On the Electro-dynamic Forces, by Prof. LOVERING.

4. On the American Climate and the Theories of its Storms, by Prof. HARE.

5. Upon the drift of wrecked material on the South coast of Long Island; and on recent changes in Cape Hatteras, by Lieut. DAVIS.

SECTION OF NATURAL HISTORY, GEOLOGY, &c.

1. Observations on some Tracks in the Sandstones of the *Clinton Group*, of New York, and their probable Origin; also upon some Trails in the surface of these Sandstones, by Prof. HALL.

2. On the Copper Mines of Lake Superior, by C. T. JACKSON.

3. Exhibition of some of the Bones of the Dinornis Novæ-Zealandiæ, with remarks, by Prof. CHASE.

4. On some new points in the Morphology of Cells, by Dr. W. J. BURNETT.

5. Some remarks upon Erratic Phenomena in the White Mountains, by Prof. GUYOT.

Monday, Aug. 20, 10 *o'clock, A. M.*

SECTION OF PHYSICS, CHEMISTRY, &c.

1. General Tables for the Reduction of the apparent places of Stars, by Prof. J. S. HUBBARD.

2. Notice of a Chronometric Expedition for ascertaining the difference of Meridians of Greenwich and Cambridge Observatories, by W. C. BOND.

3. Remarks on the Occulation of Aldebaran observed at Nantucket, by WILLIAM MITCHELL.

4. Determination of the Water contained in Crystallized Sulphate of Quinine, and a method for testing the purity of the commercial article, by Dr. C. LINCK.

5. On a New Method of Observing Right Ascension and Declination, by Prof. MITCHELL.

6. On the Fat of a large Sea Turtle, by Dr. C. LINCK.

SECTION OF NATURAL HISTORY, GEOLOGY, &c.

1. Observations on the Brachiopoda, &c., by Prof. HALL.

2. Remarks upon Graptolites, their duration in Geological Periods, and their value in the Identification of Strata, by Prof. HALL.

3. On the Geological Structure of Eastern Canada, by T. S. HUNT.

4. On the Mineral Region of Lake Superior, by JAMES S. HODGE.

5. On the Sediment of the Mississippi, by W. MARR, U. S. N.

6. Letter on a New Cave in Kentucky, by L. FEUCHTWANGER.

7. On the Right Whale of the Southern Hemisphere, by Lieut. MAURY.

8. On the plan of Structure and Homologies of Radiated Animals, with reference to the systematic position of the so-called Hydroid Polypi, by Prof. L. AGASSIZ.

9. On the Homologies of Acephala and Gasteropoda, with reference to the systematic position of Brachiopoda, &c., by Prof. L. AGASSIZ.

10. On the Differences between Sirenidea and true Cetacea, and the Embryonic Characters of the former, by Prof. L. AGASSIZ.

11. On the Difference between Embryonic and Prophetic Types in the succession of organized beings through the whole range of geological times, by Prof. L. AGASSIZ.

12. On Bone Caves of Pennsylvania, by Prof. BAIRD.

13. On the Genus Phalangopsis, by S. S. HALDEMAN.

14. On the Metamorphosis of the Urodelian Batrachians, by Prof. BAIRD.

15. On the Skulls of the smaller Mammalia of Massachusetts, by Dr. WHEATLAND.

GENERAL MEETING: EVENING SESSION, (in Lyceum Hall, 7½ o'clock, P. M.)

1. On Animal Morphology, by Prof. AGASSIZ.

2. On Linguistic Ethnology, with illustrations chiefly from the Aboriginal Languages of America, by S. S. HALDEMAN.

Tuesday, Aug. 21, 10 *o'clock, A. M.* [The last day of the Session.]

SECTION OF PHYSICAL CHEMISTRY, &c.

1. On Meteorological Instruments, by Prof. GUYOT.

2. Remarks on a proposed Prime Meridian for American Longitude, by Prof. HOLTON.

3. On Ammonio-chlorid of Magnesium, by Dr. LINCK.
4. Geometrical Interpretation of Analytical Notation, by J. PATTERSON.
5. On a Self-registering Anemometer, by JAMES H. COFFIN.
6. On a Curious Phenomenon relating to Vision, by Prof. LOVERING.

SECTION OF NATURAL HISTORY, GEOLOGY, &c.

1. On some Characteristic Compositæ, by A. GRAY.
2. On a Process for selecting the Remains of Infusoria in Sedimentary Deposits, by Prof. BAILEY.
3. On Leptæna and Spirifer, by Prof. HALL.
4. On the Embryology of Cephalopoda, Aphides, Birds and Reptiles, by Prof. AGASSIZ.
5. On the Histology of Invertebrate Animals, by Prof. AGASSIZ.
6. On several points of Embryology in connection with Classification, by Prof. AGASSIZ.

GENERAL MEETING.—(Four o'clock, P. M.)

1. On the Application of the Principles of Acoustics to the Construction of Lecture-rooms, &c., by Prof. HENRY.
2. On the Composition of Plant Phytons, and some Applications of Phyllotaxis, by Prof. GRAY.
3. Mathematical Investigation pertaining to Phyllotaxis, by Prof. PIERCE.